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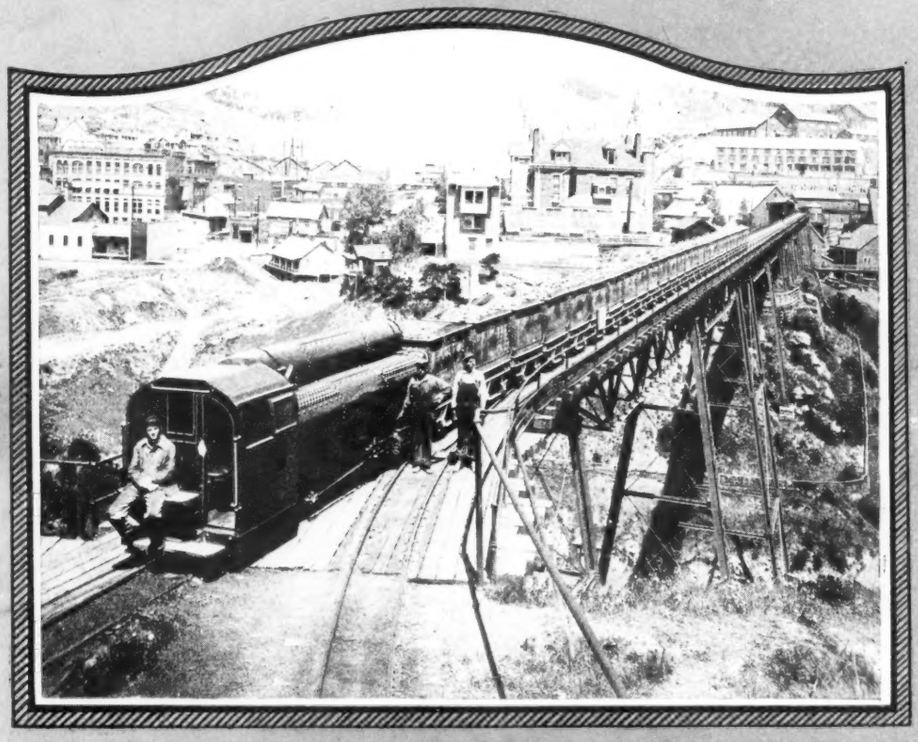

*COMPRESSED-AIR LOCOMOTIVES DO ALL THE HAULING AT THE FAMOUS HOMESTAKE MINE AT LEAD, SOUTH DAKOTA*

**How Gold is Mined and Treated at Homestake**
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VOL. XXX, NO. VIII

AUGUST, 1925

# How Gold is Mined and Treated at Homestake

By FELIX EDGAR WORMSER

THE Homestake mine in the historic and beautiful Black Hills of South Dakota has a wonderful record. It has been a gold producer almost continuously since 1878—contributing $193,545,680 in gold to the world's supply up to January of this year—and has paid to its stockholders $47,068,800 in dividends. It has taken a lead in the development of the cyanide process and in the efficient use of amalgamation in the recovery of gold. The community which has been built around the Homestake mine—the City of Lead—has an air of permanence not ordinarily associated with a mining camp. The welfare work of the company is a story by itself and is equaled by but few mining companies.

Gold production by the Homestake Company has been so standardized that it has become more of a manufacturing than a mining proposition. The gold ore, though low in value, is remarkably uniform in grade and carries from $3.50 to $4 per ton in gold, year in and year out. Naturally, the main reason for the company's success in the handling of this low-grade ore is because the deposit worked is a huge one and operations can be conducted on a large scale. As a matter of fact, from 4,500 to 5,000 tons are mined and treated daily. Like most mines, Homestake has reached its present stage through gradual growth and through additions to its plant. Consequently, the company has many units scattered in the vicinity of its mine that have been constructed as operations expanded.

The mine is situated near Lead, in fact, certain of the workings are directly beneath the town. Geologically speaking, the ore exists in an intensely folded and metamorphosed bed of dolomitic limestone, slates, schists, and quartzites of Pre-Cambrian age. The locating of the major and the minor folds and the geological interpretation of their structure are carefully done by the company's geologists, as these things have an important bearing on subsequent mining operations. The bed has an average width of approximately 50 feet; but, owing to repeated folding, the bed may frequently have a combined width of over 400 feet which permits unusually wide underground mine openings. The deepest level being worked today is the 2,200-foot level. Homestake ore, as it comes out of the mine, is rather unattractive looking. Rarely is any gold in it visible to the naked eye, as might be expected in such a low-grade deposit. In the deeper levels the gold is found in an uncommon rock mineral called cummingtonite—a variety of hornblende, in chlorite, and also in pyrite, arsenopyrite, and pyrrhotite. The ore is hard and tough.

**FOR forty-seven years, the Homestake Mine in South Dakota has been a consistent producer of gold. During this period of output there has been withdrawn from that mining property a total of substantially $194,000,000 worth of the precious metal.**

**The Homestake Mine is not a rich one compared with other mines that have yielded far more abundantly per ton of ore brought to the surface. As a matter of fact, the ore is of relatively low value although notably uniform in grade. Such being the case, most people would wonder how the mine has been able to pay so handsomely.**

**The answer is that both the mining and the milling methods employed have been developed to a high degree of efficiency, and thus it is possible to get great quantities of the rock out of the ground and then to treat the ore so as to extract virtually all of its metallic values.**

**The author tells how some of these results are obtained, and the story makes it clear how necessary compressed air is in doing many different and important parts of the work involved.**

The deposit is pierced by two vertical main shafts, known, respectively, as the Old Abe or B. & M. shaft and the Ellison shaft. These shafts are about 1,730 feet apart and are located on opposite sides of a gulch. Because the mine workings around the B. & M.—formerly the main shaft—have caused it to settle and to weaken, the center of operations has been transferred to the Ellison, which has been remodeled and modernized and is now equipped to handle 4,000 tons in 15 hours.

Homestake mining methods,* through a steady process of evolution, have developed from the early and more or less haphazard arrangement of stopes, pillars, and mine workings to the present orderly and well-planned shrinkage stoping. Although essentially simple, Homestake practices, as is the case with most mining methods, are difficult to describe. In a few words, the area to be mined is divided alternately into rooms 60 feet wide and pillars 42 feet wide. Mining begins in the rooms and is carried upward for about 25 feet, when the ore is removed from the stope as mined. Next, this ore is replaced with waste filling, which is allowed to flow from a raise into the stope until up to the level above. This fill naturally arches on the stope floor. Mining is next begun on the pile of waste and carried upward to within 25 feet of the level above. As mining proceeds, enough ore is drawn from each stope to leave a working space for the miners in a stope. Finally, all the ore is withdrawn from the stope, which is then completely filled with waste. In recovering the ore from the

*"*Mining Methods at the Homestake*," by *A. J. M. Ross and R. G. Wayland, published in Transactions of the A. I. M. E. February*, 1925.

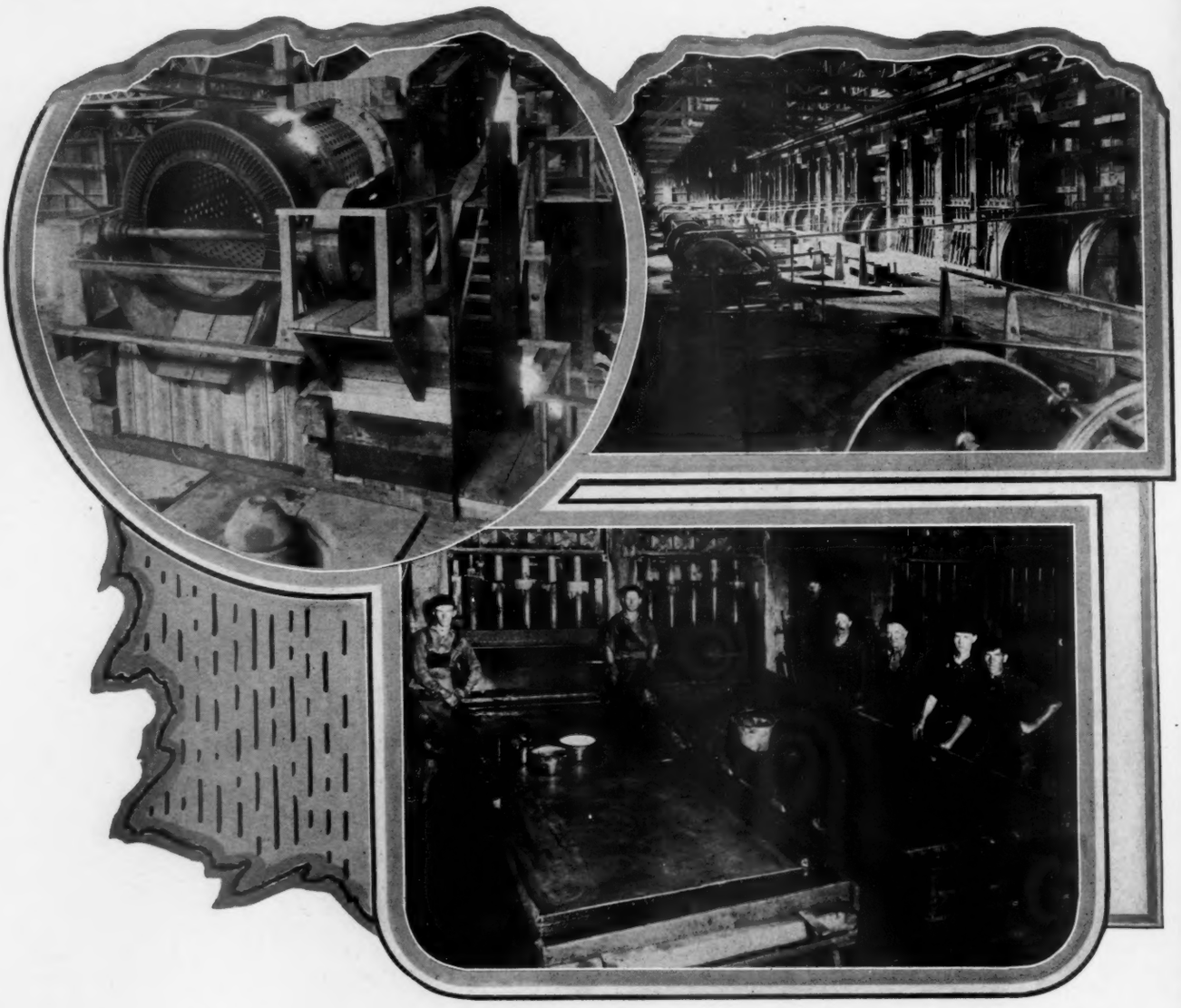
pillars and the crown, or the ore within 25 feet of the level above, square-sets are used.

About 50 per cent. of the ore hoisted is obtained from shrinkage stoping, as described in the foregoing. The remainder comes from glory-hole and draw-hole operations in old caved workings, above the 500-foot level, where the early mining of the ore body resulted in much caving. The glory hole is a large open pit in the bottom of which are several large mill holes through which the ore, broken in the glory hole, is dropped to the mine below, trammed to the shaft, and hoisted to the surface.

The levels in the mine are 100 feet apart down to the 1,100-foot level. Below that they are spaced 150 feet apart. At the B. & M. shaft, loading stations with measuring pockets for loading the skips quickly and accurately are located just below the 800-, the 1,100-, and the 1,550-foot levels. These measuring pockets are the exact capacity of the skips. The ore is hoisted from these pockets and crushed in gyratory crushers near the headframe. In the Ellison shaft, the main skip loading pockets have been constructed on the 800-, the 1,400-, and the 2,000-foot levels; and primary crushing takes place underground at each of these stations. A 36x48-inch, electrically driven jaw crusher, fed by an apron feeder, does the trick at each station. The crushers are set to 4½ inches, and they discharge into a 1,500-ton storage pocket from which the ore passes to the measuring and loading pockets. The vertical space required for each of these installations is so great that the loading of the skips takes place about 150 to 200 feet below the level on which the crushing station is built. The loading-pocket gates are operated by compressed air controlled by a valve manipulated by a laborer who attends to the loading.

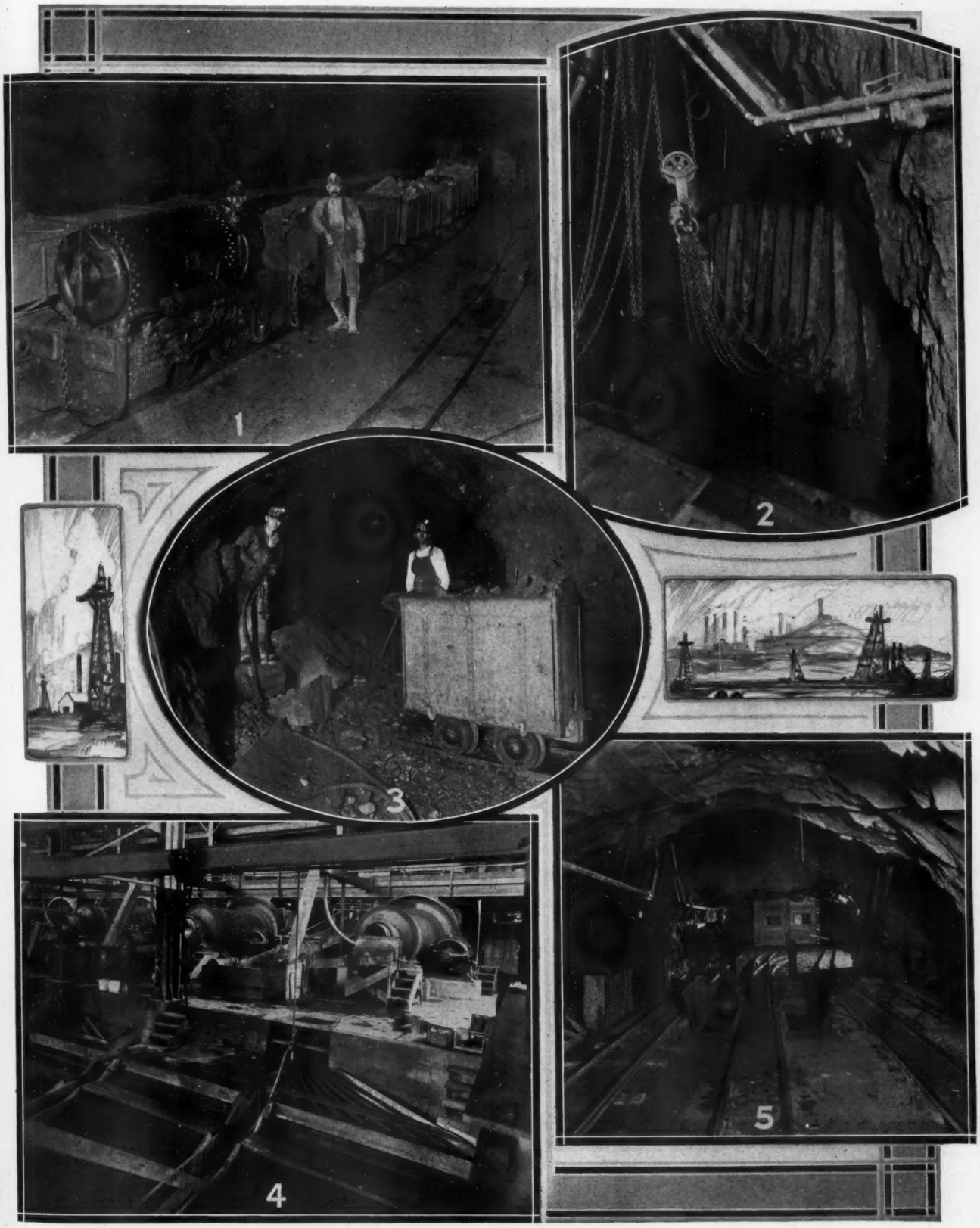
Various types of air-driven rock drills find favor at the Homestake mine. For drifting, crosscutting, and stoping in shrinkage stopes the drifter type of drills, mounted on columns, are used, while wet stopehammer drills are employed for raising. Light drills are utilized for the great amount of blockholing that has to be done underground, for the ore generally breaks into large pieces. Quarter-octagon, 1-inch hollow drill steel is the standard used in all machines. The bit found most satisfactory for drifting, raising, and stoping is the double-taper cross bit, while the rose bit is used in blockholing. Straight shanks are the rule. A large and a well-equipped sharpening plant with pneumatic sharpeners keeps the drill steels in shape.

The Homestake is one of the few mines in the United States employing compressed air for underground and surface haulage. The use of compressed air for this work does away with the danger attending electrical haulage, with its exposed wiring, but does require air-charging stations at many places underground. A total of 29 air-operated locomotives



Photos by A. Lease, Lead, South Dakota.

**Left—Part of the Ellison surface crushing plant. Trommels are used to screen the mine product before delivering the ore to gyratory crushers.**
**Right—Interior of one of the older stamp mills.**
**Bottom—Dressing the amalgamation plates in one of the older mills. The gold amalgam is brushed off the plates and squeezed in a press to remove the excess quicksilver.**




Photos by A. Lease, Lead, S. D.

**Fig. 1—There are 29 compressed air locomotives used at Homestake to do hauling both underground and on the surface. This shows a 3½-ton locomotive equipped with a tank which holds air at a pressure of 900 pounds.**

**Fig. 2—A finger gate. By raising and lowering the heavy iron fingers the flow of ore into the underground crusher bin can be closely regulated.**

**Fig. 3—Blockholing large pieces of ore with a "Jackhamer."**

**Fig. 4—In the second step of grinding ore at Homestake the rock mills receive the classified sand discharged from the stamps, grind it, and pass it over the silver-plated amalgamation plates seen in the foreground.**

**Fig. 5—At Homestake, the ore is partly crushed underground; and here we have one of the big crushing stations where the ore is broken by jaw crushers into pieces not larger than 4½ inches.**

is owned by the company. Twenty of these are 5-ton engines, each with a tank capacity of 40 cubic feet of air at 900 pounds pressure. They have 6x10-inch cylinders, and are equipped with reducing valves to supply air at 160 pounds pressure. The remaining locomotives are 3½-ton machines with 5x8-inch cylinders and a tank capacity of 20½ cubic feet. Ore trains are made up of 20-cubic-foot cars having either end-dump or gable bottoms. The track is of 18-inch gage; and 40-pound rails are used.

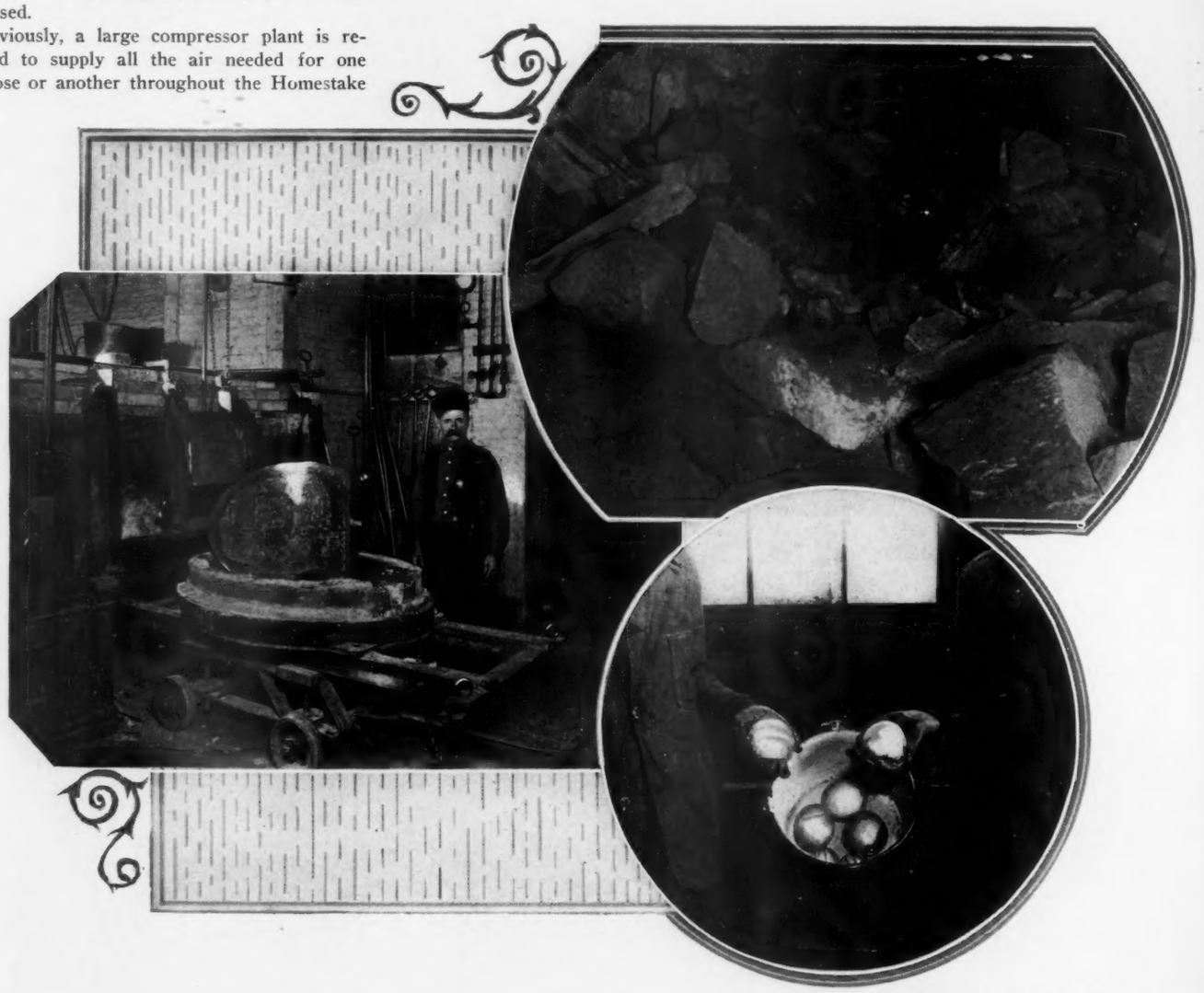
Obviously, a large compressor plant is required to supply all the air needed for one purpose or another throughout the Homestake workings. High-pressure air, piped to the various levels of the mine, is furnished by one Ingersoll-Rand "PRE-4," 4-stage, 1,000-pound unit driven by a synchronous motor. The machine has a stroke of 24-inches. An old Ingersoll-Sergeant compressor stands ready to be used in case of emergency. This machine has air cylinders that are 37¼, 20¼, 12½ and 6 inches in diameter with a 48-inch stroke. It was designed for steam power but is now driven by an electric motor through rope drive. As a further protection against any interruption of the air supply, the company has still another high-pressure compressor, driven by steam, having air-cylinders 24¼, 14½, 9¼, and 4½ inches in diameter with a 42-inch stroke. Besides these high-pressure machines, four other units provide air for the drills.

Last but not least, air at extremely low pressure is supplied by an exhaust fan for ventilating the mine. This fan, located at the shaft collar, has a capacity of 250,000 cubic feet per minute, while two 60,000-cubic-foot-capacity auxiliary fans of the sirrocco type, at the 1,400- and the 1,800-foot levels, assist forced ventilation.

In the conduct of the Homestake Company's operations much power is used in the production of compressed air. It has been estimated by company officials that of a total of 13.06 horsepower-hours per ton of ore hoisted 5.13 are consumed in rock drilling, sharpening, loading, blowing, and for other purposes. Mine ventilation accounts for 1.84 horsepower-hours. Hence, about 53 per cent. of the power used in underground operations has to do with compressed air in its numerous applications

The Ellison, as previously mentioned, is now the main working shaft, and was remodeled three years ago to increase its capacity. It had been designed for cage hoisting; but as the use of skips increases the capacity of a shaft it was converted to skip hoisting by a simple repartitioning. As it stands to-day, this shaft has two cage compartments, one cage compartment for handling men and supplies, one pipeway, and one manway. A new hoist was erected to operate 7-ton skips in balance at a speed of 2,000 feet per minute. The hoist is electrically driven by a direct-connected, direct-current, 1,400-H.P., 600-volt motor. A flywheel generator set in the hoist house takes care of peak loads in hoisting. The B. & M. shaft is equipped with a steam hoist with flat ropes. It has an estimated rating of 2,500 H. P.

The treatment of Homestake gold ore is simple, and yet extremely efficient. Home-



Photos by A. Lease, Lead, South Dakota.

**Left—In the refinery, showing a cupel in the foreground.**
**Right—How the ore breaks. The large chunks have yet to be broken up.**
**Circle—Balls of amalgam ready to go to the retort where the quicksilver is distilled from the gold.**

**Part of Homestake's surface plant. Old Abe shaft is in the background. At the left may be seen the edge of the glory hole from which some ore is still obtained.**

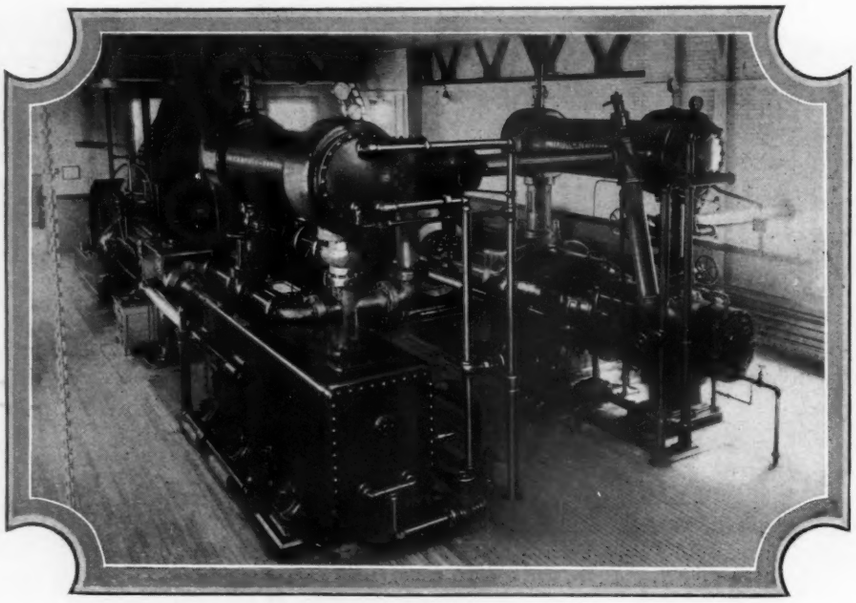
stake gold metallurgy has long been in the van—many notable contributions to technical literature have come from there. About 95 per cent. of the gold in the ore is recovered, roughly, 75 per cent. by amalgamation—an art which probably has been developed to a higher degree at Lead than anywhere else in the world—and the remainder by cyaniding. Three of the company's mills, the Amicus, Golden Star, and Pocahontas, are grouped close to the B. & M. shaft and contain a total of 660 stamps. Another newer unit, called the South Mill, is nearer to the Ellison shaft and was erected in 1922. On the north side of the Homestake property are located the Monroe and the Mineral Point mills with a total of 220 stamps. In addition to these units there is a sand plant which handles the pulp to be leached with cyanide solution, while a slime plant, at Deadwood, treats the slimes from the stamp mills.

Although the metallurgical plants of the company are many and rather widely distributed, the process used is not complex and will be understood from a description of the newest plant, the South Mill, which embodies the latest Homestake practice. Briefly, the procedure is to crush the ore by stamps and then to pass it on to rod mills for further comminution. After that the pulp goes over silver-plated amalgamation plates to catch the free gold in the ore. The pulp is then separated by cone classifiers into two products: sand and slimes, both of which are given treatment with cyanide solution to extract the gold. Finally, the dissolved gold is precipitated on zinc dust and melted into the form of gold bars.

The South Mill—an imposing, well-lighted, steel structure standing on a hillside—is only a crushing and an amalgamation plant. Ore for this plant comes from the Ellison shaft in trains, drawn by compressed air locomotives, that dump into an inverted V-bottom bin holding 7,200 tons. Ore is fed from these bins to

**The South Mill, containing 120 stamps, crushes the ore delivered from the mine. On this same steel structure is housed an amalgamation plant.**

a battery of 120 stamps, weighing 1,550 pounds each, which are driven by electric motors in groups of five. These stamps drop at the rate of 100 times per minute and crush the ore wet to ½-inch mesh. From the stamps, the pulp passes to dewatering cones—the undersize material from the cones being ground in a set of six rod-mills working in parallel with a Dorr classifier. The classifier product goes over silver-plated amalgamation plates and is then separated in cone classifiers into sands and slimes for cyanide treatment. The South Mill has a capacity of 1,800 tons of ore per day.



**Here we have one of the first high-pressure air compressors used at Homestake. Originally built to be operated by steam, this four-stage machine is now driven by a synchronous motor.**

A visitor cannot help but be impressed with the orderliness and cleanliness of all the Homestake mills. Old though some of them may be, they remain splendid examples of modern metallurgical practice in the treatment of gold-bearing ores.

Homestake is about as near to being self-contained as any mining camp can be. It has its own carpenter, machine, and foundry shops where not only heavy repairing can be done but where much of the machinery used in the mine, the mills, and on the surface can also be manufactured. It has its own power-generating plants which are in part steam operated, as at Lead, and in part driven by hydro-electric energy, as at Spearfish. The timber used in the mine is cut from tracts owned by the company; the coal burned under the boilers in the power houses is mined on company land; and lime quarries supply the lime necessary in certain operations.

This short sketch would not be complete without some reference to Homestake's welfare work. The company has provided the town of Lead with a library and a recreational hall, where a swimming pool, bowling alleys, and a pool and billiard room are available for the free use of the entire community—as well as strangers. The company has also constructed a theater which can be enjoyed at a small admission charge. A recently built hospital furnishes medical attendance without cost. It is no wonder then that Homestake has one of the pleasantest-appearing and finest mining camps in the world and a force of workers that has been in the employ of the company for a long time. Mr. B. C. Yates is general superintendent.

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China is the principal factor in world trade in egg products, and supplies 90 per cent. or about 107,500,000 pounds of the total annual exports of albumen, yolk, whole egg, liquid egg, dried egg, and frozen whole egg. Just how this business has grown is brought out by the fact that China exported but 45,000,000 pounds of these commodities a decade ago.

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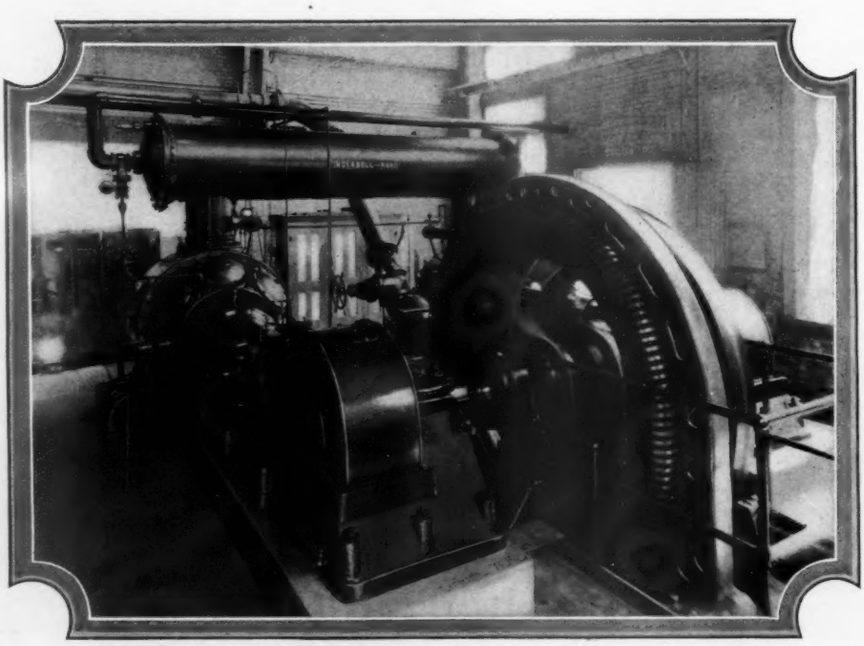

**This compressor furnishes 4,500 cubic feet of air per minute, at a pressure of 100 pounds, for many uses throughout the mine and the mill.**

A nationally known mail-order house is to offer coal in carload lots direct from mines in Illinois, Indiana and Kentucky, and it is said that this will eliminate middlemen, jobbers, agents, and salesmen, and make for an important saving in the cost to the purchaser. To quote *Coal Age*: "When the coal is shipped we send a bill to the nearest bank and a copy to the purchaser and all the consumer has to do is to pay the bill at the bank. Then an order is issued on the railroad to deliver the coal." We are not informed as to the limits of the territory reached.

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## A FORD PLANT TUNNEL

THE Ford Motor Company of Canada has commenced the construction of a tunnel 2,000 feet long and 6 feet wide to carry steam pipes from the company's main plant in Ford City to the new power house near by. It will be remembered that a similar tunnel carrying steam pipes, air pipes, water pipes, and electric service wires to the various buildings is an important feature of the Phillipsburg plant of the Ingersoll-Rand Company.

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A 200-ton "dredger" has been launched to be used for tin mining in Cornwall, England. Such dredges have been used extensively for this purpose elsewhere but never before in that locality. It seems likely that certain of the alluvial platinum fields in the Northern Transvaal will be worked by dredges, this being suggested in a recent prospectus of the Lydenburg Consolidated Platinum Company.

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A plan is developing for the construction of a canal capable of accommodating 100-ton barges from Birmingham, England, to the sea. It will be 82 miles long and the cost will be about $30,000,000. There is already some water communication, but the new route will be of much greater capacity, and the time of transit will be reduced by one-third.

# More Facts About America's First Families

By THOMAS DIGGER

THERE are people in this country that point with much pride to the fact that their forebears reached the shores of America 300 years ago. According to these prideful people they are entitled to a certain amount of social preëminence because of the venturesome enterprise of their ancestors. This gentry need not be at all stuck up, because there were a whole lot of far more enterprising people here some 2,000 years earlier—if not still earlier. We have this information from inquiring scientists that have been making archeological investigations in the far West.

Down in the southeastern corner of Nevada, where the Muddy River trails its chocolate-colored course toward the Colorado, lies the Moapa District; and in that inhospitable desert region, between the towns of St. Thomas and Overton, an ancient Indian city has been found which may have been in its prime at the very beginning of the Christian era. This great Indian pueblo—or what remains of it—extends for a distance of fully six miles, and it may possibly have been the cradle of Pueblo culture. This revelation is the outcome of the joint efforts of Governor Scrugham of Nevada and Dr. M. R. Harrington of the Museum of the American Indian, Heye Foundation, New York City.

There has long been a tradition which has perpetuated a colorful story of the lost city of Nevada. This story is said to have made an irresistible appeal to Governor Scrugham; and, as a consequence, he carried on on his own account certain explorations which brought to light very interesting traces of a departed people and evidences of a rather advanced stage of culture. Doctor Harrington, assisted by Mr. C. O. Turbyfill, joined hands with Governor Scrugham, and last November they began excavating the sand which almost wholly covered the site of the ancient city or cities, except here and there where the corner of a prehistoric stone dwelling jutted out of the dismal dunes.

Where the cloak of drifting sand has been removed, numberless fragments of pottery have been picked up in the silent streets and plazas of this erstwhile populous community. The pottery is manifestly of a very ancient type. It is believed to be among the earliest forms connected with the prehistoric period of the Pueblo Indians. By way of decoration, the earthen vessels are painted in characteristic designs of black on gray or black on red. The modeling of the pottery indicates plainly that the people had no knowledge of the potter's wheel nor of the art of glazing.

The buildings are generally square, containing from one to three rooms. There are, however, some round *kivas* or ceremonial chambers within which were undoubtedly conducted secret tribal rites connected with religious ceremonies. One of the most interesting discoveries made is that the dwellers in this lost city, which has been appropriately named Pueblo Grande de Nevada, were accustomed to bury their dead in the floors or ruins of abandoned houses, or, perhaps, they abandoned these houses after persons had died and been buried there—a custom prevailing among many surviving Indian tribes.

With the remains of these remote Americans have been found pottery water bottles, handsomely decorated, as well as beautiful eating bowls fashioned of clay. Again, some of the graves have revealed prehistoric jewelry consisting of turquoise and shell beads; and remnants of robes woven of strips of twisted fur; fragments of sandals; coiled basketry; and even a set of bone dice. Manifestly, gambling or games of chance were known to the citizenry of Pueblo Grande; and they were not indifferent to the parade and the demands of creature comfort universally associated with a somewhat advanced stage of communal life.

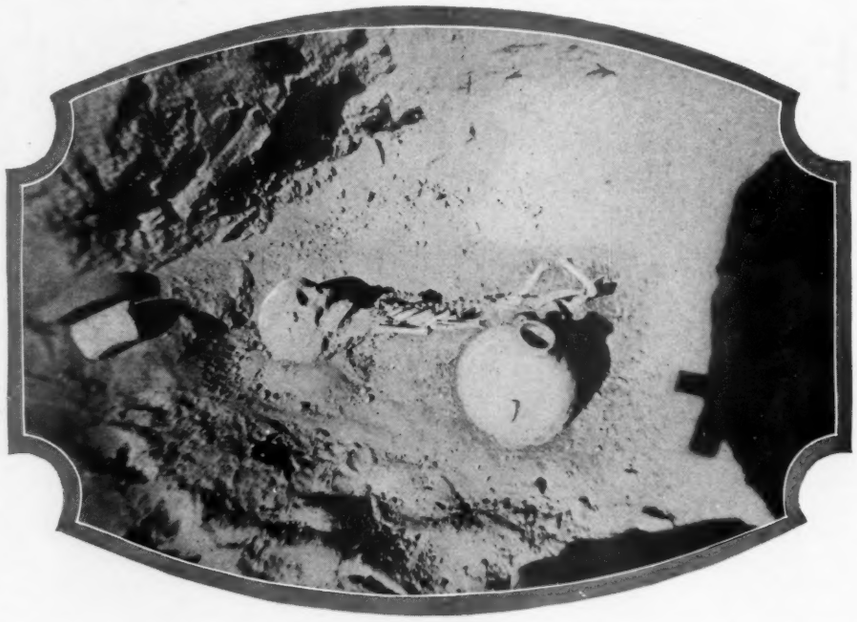
**Left—Part of Pueblo Grande de Nevada after the removal of sands accumulated during many centuries. Right—Broken bits of rock which indicate that man once inhabited the desert region in which Peublo Grande de Nevada is set.**

According to an announcement made by the Heye Foundation, the age of Pueblo Grande must be very great. The character of the pottery seems ancient; the small houses are simple in comparison with the present communal houses of the surviving Pueblo tribes which rise story after story into the air. Again, parts of the city have been rebuilt two and even three times—one house being supplanted by another. Extensive erosion, which has taken place since the city was abandoned, indicates great age, because such washing away follows very slowly in a dry desert country. Deep beds of ashes formed by successive fires are also an indication of age; and there are none of the evidences of contact with the white man, such as the presence of glass beads, crockery, glass, and metalware

which almost always marked the early white man's intercourse with the Indians. Furthermore, very little stone has yet been found in the construction of the uncovered buildings. This is contrary to the more recent pueblos, which are constructed largely of stone. On the other hand, adobe or sun-baked clay bricks, shaped like loaves and laid in clay mortar, and adobe floors have been brought to light in the excavations at Pueblo Grande.

Archeologists class as pre-Pueblo ruins of the type prevailing at Pueblo Grande—that is, they belong to a remote period which preceded the culture or civilization of the Pueblo tribes that were found in New Mexico and Arizona by the early Spaniards and that are today represented by the Zuni, Hopi, and certain other native Indian tribes.

According to a news dispatch, printed in the *New York Sun* some weeks back, Doctor Harrington is quoted as follows: "The inhabitants of Pueblo Grande de Nevada were rather shorter than modern Americans. The tallest skeleton thus far found was of a person who could not have been more than five feet eight inches high, while the average was between five feet and five feet six inches. The greatest age ascribed to the ruins is 2,000 years."



**This ancient American enjoyed life something like 2,000 years ago, and may have been one of the leading citizens of Pueblo Grande de Nevada.**

## AIR BRUSH USED TO APPLY WATERPROOFING

THE appearance of numerous cracks in the concrete girders, deck, and railing of the Santa Margarita River bridge, in California, made it necessary to waterproof this structure to prevent further deterioration. Located on the ocean front and spanning tidewater, the bridge is at all times exposed to the moisture-laden salt air which has caused the reinforcing steel embedded in the structure to rust. This has resulted in the swelling and the cracking of the concrete, which is not of the quality now specified for state-highway bridges.

After a careful investigation it was deemed advisable to waterproof the entire structure. To this end, the visible portions of the bridge were painted with "Stone Tex"—a waterproof paint with a dull concrete-like finish. The girders and the underside were coated with petrolastic cement which was applied by means of a pneumatic paint-spraying outfit equipped with two air brushes. This part of the job was done first to avoid spattering the black compound on the hand-painted surfaces.

To facilitate the work, the air-brush operators did most of their cementing from a raft, on which suitable staging had been mounted. This mobile platform could be floated readily from place to place, thus greatly expediting progress. Other state-highway bridges in the State of California, similarly affected, are now undergoing the same preservative treatment.

**Top—Wheel guard and railing as they appeared after coating with damp-proof paint.**
**Circle—Close-up of paint-spraying equipment.**
**Bottom—Men at work on scaffolding supported by the bridge. Note the other platform beneath the bridge which was mounted on a raft.**

## AN IMPROVISED GAS MASK

AT Arcady Farm, Rondout, Ill., so we learn from *Ice and Refrigeration,* a new charge of ammonia was being put into a refrigerating system when the accidental breaking of a pipe filled the place with escaping ammonia. It was imperative to keep things going; but it was impossible to get at the valves. Telephoning for 25 miles around failed to locate a gas mask.

Finally, a large turkish towel was saturated with a solution of vinegar and water, half and half. The towel was tied over a man's head, knotting it at the top and around his neck in such a way that it hung loosely over his cap visor—forming a roomy bag over his face. The open weave of the towel enabled him to see sufficiently to find his way to the leak; to close the valves; and to open the windows. The vinegar neutralized the ammonia gas; and the man felt no ill effects from his exploit.

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To know the age of a horse, if not too old, you examine its teeth. To tell the age of a fish, regardless of age, you look into its ear. Prof. W. J. K. Harkness, of the University of Toronto, says that in the internal ear of a fish there is a little bony pocket. In this pocket is a tiny stone, called "otholith," which rolls about as the fish tips this way and that way and helps him to know if he is right side up. As the fish grows older the otholith grows larger, and the age of the fish may be determined from the size of this stone.

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India is the second largest producer of sugar in the world.

# Increasing the Capacity of the Suez Canal

By F. A. CHOFFEL

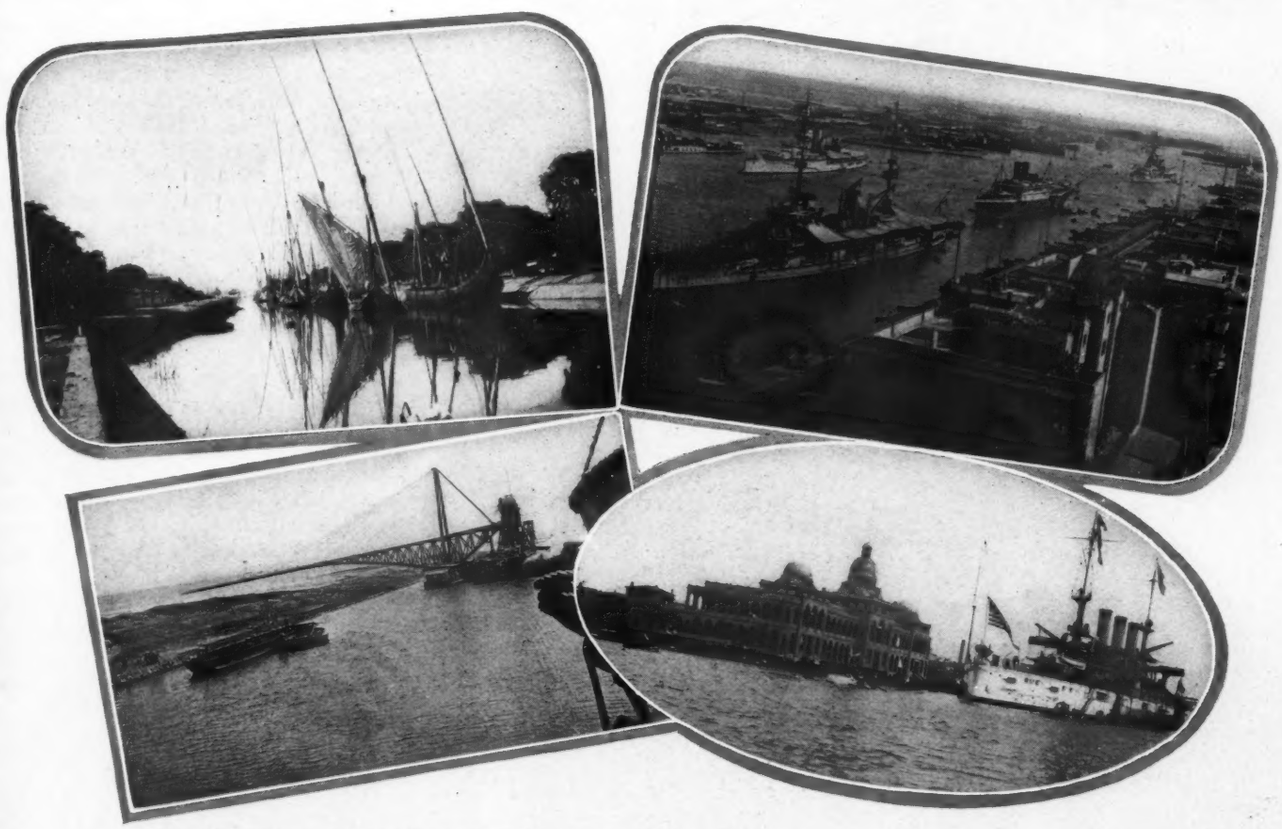
THE Suez Canal, as most of us know, is a man-made waterway which links the eastern end of the Mediterranean with the northernmost arm of the Red Sea, and since 1869 has constituted the shortest navigable route between Europe on the west and India, China, and Japan on the east. The construction of the Suez Canal was not undertaken until after centuries of intermittent agitation in behalf of the project. As a matter of record, we are told that such a scheme was proposed in the eighth century by Harun al-Rashid, who subsequently decided against the plan fearing lest such a water route would expose the coast of Arabia to the attack of the Byzantine navy.

The canal, as we know it today, was conceived by that French engineering genius Ferdinand de Lesseps, who became the foremost exponent of the project as early as 1854. In that year, de Lesseps obtained a concession from the viceroy of Egypt which authorized the formation of the *Compagnie Universelle du Canal Maritime de Suez*. The digging of the canal was started in 1859; and the waterway was formally opened for traffic in November of 1869. It is a matter of record that de Lesseps had to overcome many fiscal difficulties in order to carry the undertaking through to completion; and, incidentally, when sufficient labor failed him, it was necessary for him to devise and to bring to his aid mechanical means for performing essential dredging. Unquestionably, the building of the Panama Canal would have been much longer delayed had it not been for the initiative of de Lesseps and what he showed could be done by means of machinery.

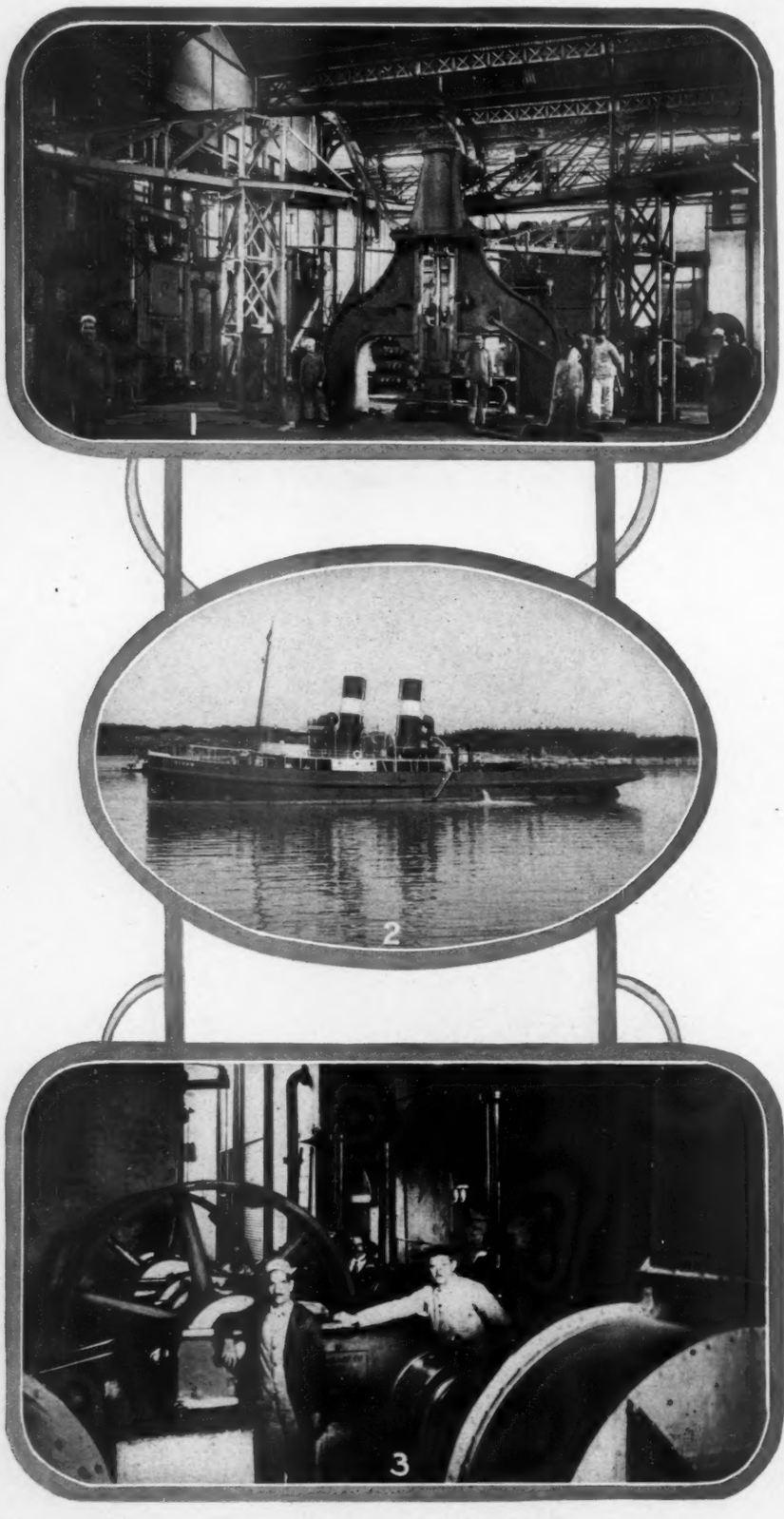
As first constructed, the Suez Canal had a total length of 102 miles; but this has since been increased 2½ miles by the building of important works at Port Said. Indeed, the works at Port Said were completed only a few years ago, and include, among other things, a safety embankment. The construction of this embankment became necessary owing to the sweep of strong currents which induced silting at a rate equivalent to almost 100,000,000 cubic feet an hour.

In the early days of the digging, the work was executed exclusively by manual labor, and in some cases the mud was actually cleared away with bare hands, so it is said. Up to 1865, more than 30,000 laborers worked simultaneously on the job. After that date machinery was used on a large scale, and steam dredges were employed which pumped up the sand and discharged the excavated material through metallic piping to points 200 feet away on either side of the great ditch. These facilities greatly reduced the number of workers needed to carry on operations.

Lake Timsah intersects the canal for a distance of six miles about mid-length of the waterway, and further to the south the canal route traverses Bitter Lakes, where Nature has helped the engineer by providing a much longer passage. On the largest of these lakes, the ship channel is beaconed for 13½ miles, after which there is ample water for a much freer movement of craft. Before the canal was taken in hand these several lakes were dry depressions in the terrain which became filled by water carried to them by the canal, itself.



**Top, Left—Native craft on the water front of Ismailia.**
**Top, Right—The harbor of Port Said.**
**Bottom, Left—Type of steam dredge used in widening the Suez Canal and in keeping the channel clear.**
**Oval—American battleship moored in the harbor of Port Said near the offices of the Canal Company.**



Unlike the Panama Canal, the Suez Canal has no locks because the elevations of the Mediterranean and the Red Sea are so nearly alike that no currents are induced that occasion navigational difficulties. As first constructed, the canal had a depth of 26 feet. Later, this was increased to 36 feet; and work now in hand, when finished, will insure an average depth of not less than 40 feet. Big steamers now passing through the canal draw a maximum of 31 feet, and craft having a draft of 33 feet will use the waterway before long. In short, the growth of shipping compels the continual amplifying of the canal's dimensions so as to provide suitable leeway for the safe movement of the great tide of traffic which makes its way to and fro through the canal.

Originally, the bottom width of the canal was but 72 feet, while at the present time the bottom width is 150 feet. The intention is to augment this to 300 feet. Today, the surface width of the canal varies from 310 feet as a minimum to a maximum of 525 feet at some points. The minimum width is to be increased to 440 feet when work in hand is finished. Formerly, it was not possible for ships of more than 4,000 tons to traverse the canal, but now vessels of 20,000 tons can make the run without hazard.

The trip through the canal takes 16 hours—only 14 of which represent progress. About 15 ships go through the canal every 24 hours; and their navigation, day or night, is supervised by expert pilots. A good idea of the part played by the Suez Canal in shortening the journey to and from the Orient can be realized if we contrast the tonnage figures of the past with those of fairly recent date. In 1870, the number of vessels using the canal was 486, representing a total of 436,609 net

**Fig. 1—Steam hammer in the Canal Company's shops at Port Said.**

**Fig. 2—Type of powerful tugs used to assist ships passing through the Canal.**

**Fig. 3—Compressor room in the Company's shops at Port Said.**

**Fig. 4—Moving one of the great steam dredges to a new point of attack.**

tons. During 1913, a matter of 5,085 ships entered the canal, and these vessels had a registered capacity of 20,033,884 net tonnage. Naturally, traffic was interrupted during the period of the World War and fell off considerably. Recovery has been hampered; but, even so, the latest figures available—those for 1923—show that 4,621 craft then used the canal and that those steamers had a combined net tonnage of 22,730,162 tons.

When plans for the canal were first made it was not contemplated that mechanical drilling would be required in clearing the way for this man-made water route. In fact, the northern half of the canal was excavated through sand. The southern half of the canal—that is, up to Bitter Lakes—is carried through a formation composed of marl, and it was not until the section between the lakes and Suez was cut that rock was encountered. This rock was drilled for blasting; and it is interesting to recall that the canal for some distance was carried through a great ledge of rock salt.

Where the banks of the canal are protected from erosion and other injury by a surfacing of rock, this rock, as well as similar material for the construction of embankments in Port Saïd, has been obtained at inland quarries in the neighborhood of Suez. These quarries are equipped with up-to-date air-driven rock drills, and are now in full operation. Already, they have furnished many million cubic feet of stone.

The workshops maintained in Port Saïd by the canal company are of importance and employ something like 1,200 mechanics. These workers are kept busy repairing and overhauling a considerable fleet of powerful tugs, steam dredges, floating cranes, etc. The shops are equipped with thoroughly up-to-date machinery; and the plant includes foundries, boil-

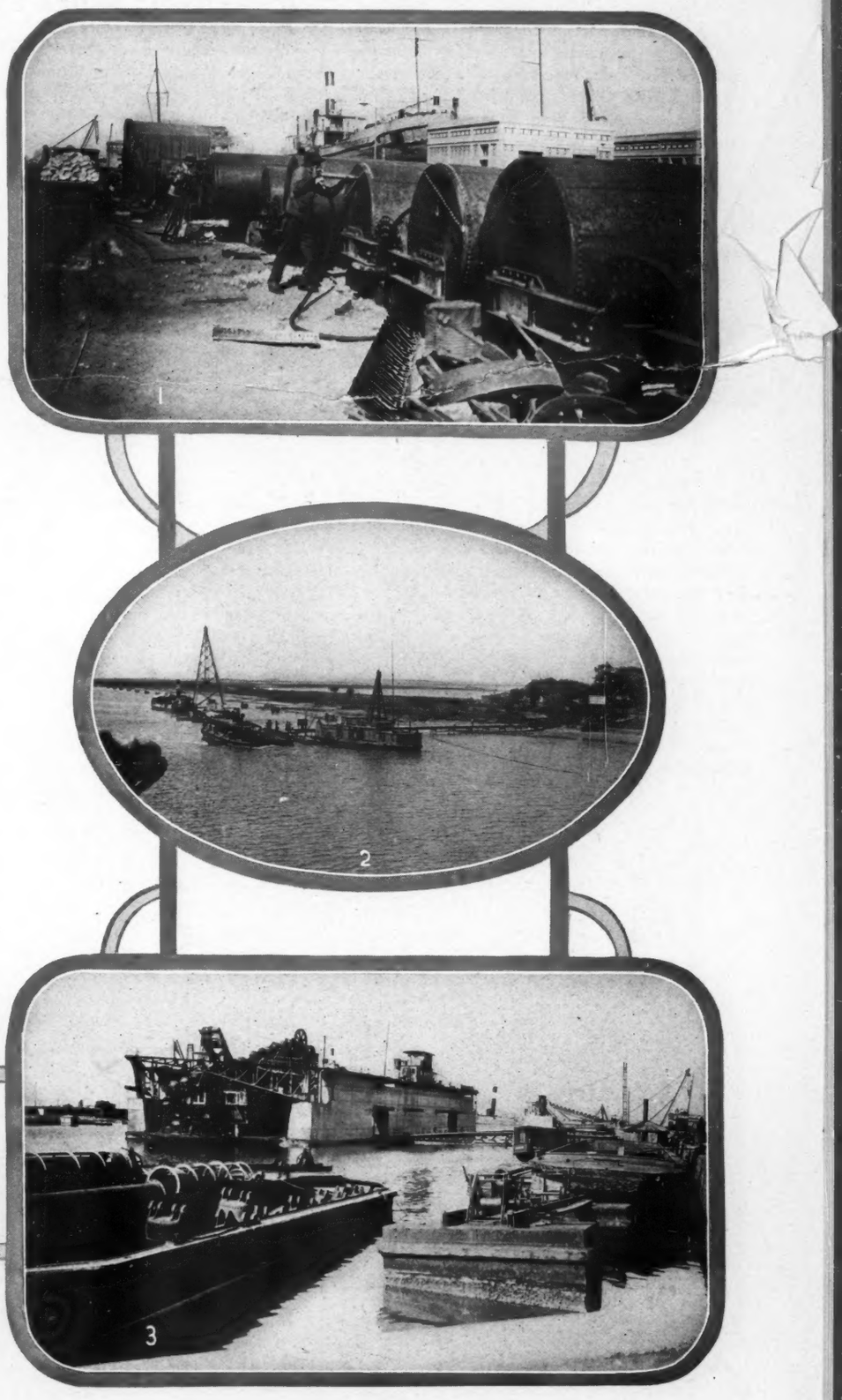


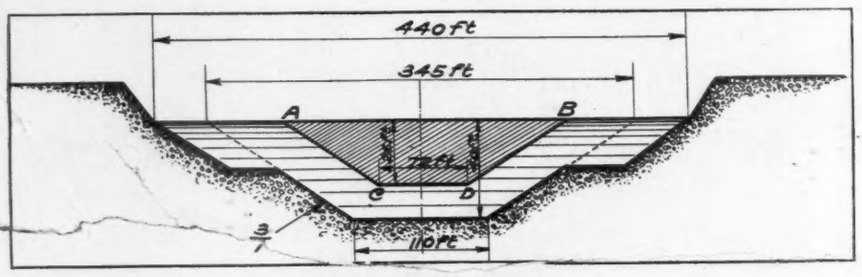

**Fig. 1—Air-driven riveters repairing steel mooring buoys.**

**Fig. 2—Dredges at work along the Canal.**

**Fig. 3—Where the Canal Company overhauls and holds in readiness various floating equipment.**

**Fig. 4—Floating dry-dock capable of lifting a fairly big vessel.**

er shops, plate mills, drydocks, etc. Needless to remark, there are air compressors and various kinds of pneumatic tools to meet the many and differing demands made upon the establishment. The central station which furnishes energy for the numerous departments has a rated output of 2,000 H. P.




**Cross section of the Suez Canal. The hatched area represents the section of the Canal when first put in service in 1869.**

Three towns have been called into being along the canal. These are: Port Saïd, on the shore of the Mediterranean, having a population of 70,000; Ismailia, situated near the midlength of the canal; and Port Thewfik, at the Red Sea outlet of the canal and about two miles from the Village of Suez. Port Saïd is the industrial center of the canal zone, while pretty Ismailia is the seat of administrative headquarters.

The author wishes to acknowledge his indebtedness to the *Compagnie Universelle du Canal Maritime de Suez* for the drawings and the photographs illustrating this article.

## "JACKHAMERS" WIDEN FIELD OF USEFULNESS

IN his 1924 report to the shareholders of the Sub-Nigel Gold Mining Company, Ltd., South Africa, Mr. G. C. Jones, manager, made the following remarks about that company's experience with wet "Jackhamers" for stoping:

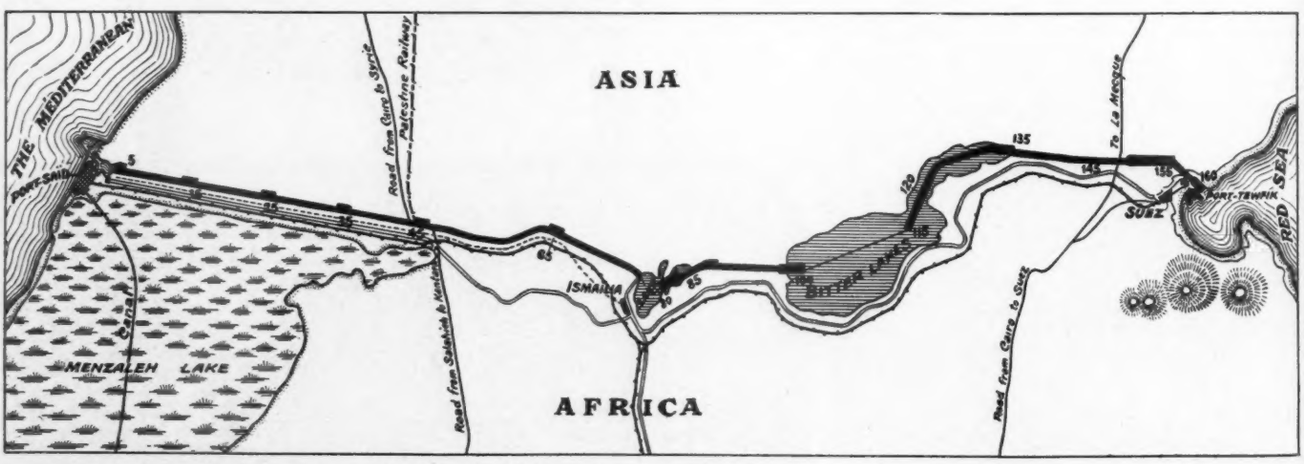
"During the last four months of the year further reductions in working costs were effected by the introduction of wet jackhamer machines for stoping. The installation of these machines is complete. The average fathoms broken per machine shift for 'Leyner' machines for the six months prior to the introduction of the wet jackhamer was 1.78, whereas the average for the latter machines for the last three months of the year was 2.39. This increase in breaking efficiency is accompanied by reductions in the amount of native wages paid; in the consumption of explosives, compressed air, and drill steel; and in the cost of rock-drill maintenance, timbering, and packing—the total reduction in working costs under these various headings being estimated at about 2s. per ton milled.

"The full effect of jackhamer machines upon stoping widths was not felt, as these machines were only in operation for the last three months of the year. It is considered that their use will result in a further reduction in stoping widths—an important factor, as there are considerable borderline bodies of ore at present classed as unpayable which will then be rendered payable. The average stoping width for the year was 39.5 inches, as compared with 39.4 inches for the previous year—figures that do not reflect the general position owing to the unusually large width of reef met with in E Shaft stopes during the year."

## STURDY CONCRETE CHIMNEY HARD TO RAZE

AT a mine in Minnesota, a tall chimney—built in 1914 of reinforced concrete—was recently demolished, and the *Explosives Engineer* gives an interesting account of the difficulty experienced in bringing down this structure. First, a series of 24 holes was drilled around one-half of the base—each hole being loaded with half a stick of dynamite. These holes were fired simultaneously, knocking out all the masonry on that side but leaving the stack unmoved.

The other half of the base was then perforated and charged in the same way with dynamite. Even after firing these charges and breaking away the remaining masonry at that point the chimney still stood: it was being held up by the reinforcing steel although moved bodily three feet to one side. Two "lifting" holes were then drilled under the middle of the structure; and when their charges were fired the chimney was finally brought to earth.




**General plan of the Suez Canal. Figures indicating distances are in kilometers.**

The upbuilding of industry in Brazil began at a fairly recent date. Prior to 1889, when the republic was established, there were only 626 factories in that country. According to statistics for the year 1920, just announced by the ministry of agriculture, commerce, and industry, Brazil then had 13,338 industrial establishments credited with a total annual output valued at approximately $672,564,600.

The latest Canadian budget provides for an export duty of three-hundredths of a cent per kilowatt-hour, or $1.95 per horsepower-year. At the rate at which electrical energy is now supplied to American consumers, it is estimated that the total revenue from this source would be in the neighborhood of $400 000 annually.

# Philadelphia-Camden Bridge Across The Delaware River

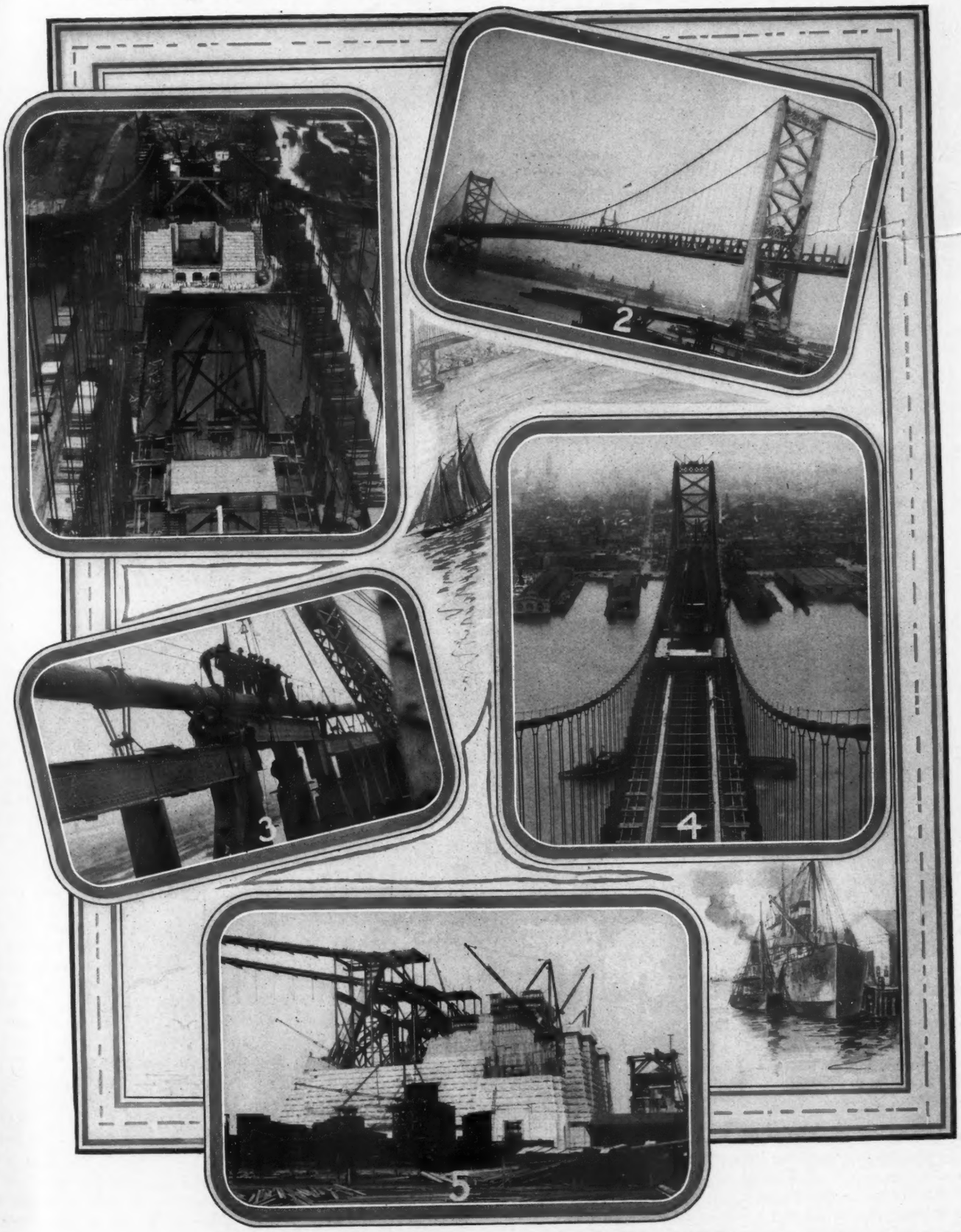



Fig. 1—Suspended structure and Camden anchorage—looking east from Camden Tower.
Fig. 2—General appearance of the bridge when viewed from the south side on the Camden shore.
Fig. 3—Close-up of part of the main span—picture taken when jacking up top chord to obtain clearance.
Fig. 4—The suspended structure as it appears looking west from the top of the Camden Tower.
Fig. 5—The Camden anchorage—giving an impressive idea of the massiveness of this part of the structure.

# "Sentinels of Safety"

By V. BROWN

MUCH of the loss of life, and many of the more or less serious accidents occurring annually in our industries are directly attributable to carelessness or to momentary heedlessness—in short, due to want of thought rather than to unavoidable hazards. To lessen this grim toll and to stimulate watchfulness and care in certain departments of our activities, the widely known publication, *Explosives Engineer*, offers a trophy which should prove a heartening and a helpful inspiration towards greater security.

"Sentinels of Safety," as the trophy is called, has been modeled by the well-known sculptor Begni del Piatta, and represents a mother and child greeting the father upon his safe return from work. Three bronze replicas of the trophy will be made: one for coal mining, one for metal mining, and one for quarrying and open-pit mining. In each case, the replica will be awarded to that mine or to that quarry which has an accident record showing the smallest loss of time in any calendar year in proportion to the volume of work done in that period.

The winning company in each of these explosives-consuming industries may, besides holding the original bronze for one year, afterwards secure and erect permanently on its property a large out-door marble replica of the trophy. In addition to the trophy, itself, awarded to the company, each employee of that company will receive an individual certificate of honor. The plan of this commendable competition was worked out in collaboration with the United States Bureau of Mines, The National Safety Council, a number of state departments of mines, and other organizations and persons interested in reducing accidents.

The trophies will be awarded annually at The First Aid Meet conducted by the United States Bureau of Mines. The Bureau has been chosen as headquarters for reports in connection with the competition because of the value of the data as a statistical aid in further assisting operators to reduce accidents. The nationwide scope of the Bureau's activities makes it better able to interpret this information than could a smaller organization and, at the same time, to convert the lessons learned into recommendations that will benefit the personnel of mines and quarries throughout the country.

Under the rules which will govern the awarding of the trophies, those eligible to compete are companies operating a coal mine employing 50 or more men underground; a metal or other mine employing 50 or more men underground; or a quarry or open-pit mine employing 25 or more men in the pit. Owing to the limited amount of office help available in the Bureau at present, the contest during the first year will be limited to the 500 mines and quarries, meeting the foregoing requirements, that first notify the Bureau of Mines of their intention to regularly report the necessary information.

The winner in each of the prescribed three groups will be the mine or quarry having the smallest loss of time from all classes of accidents in proportion to the total number of hours of work performed. In computing the loss of time from any accident, the Standard Scale prepared by the International Association of Industrial Accident Boards & Commissions will be used. Accidents ordinarily classified by the Bureau as due to explosives will carry a double penalty. Mine explosions directly traceable to the use of explosives are included under explosives accidents for the purpose of this award. Companies operating more than one mine or quarry shall furnish separate reports for each, as the trophy will be awarded to the individual mine or quarry making the best record in its respective group.


**Begni del Piatta and the model of his statue "Sentinels of Safety."**

Begni del Piatta was born in Siena, Italy, in February, 1876, and after taking a course in art and the classics in the College of La Guerce, in Florence, he returned to Siena and took up the reading of law in the university of that city. In 1906 Mr. Piatta came to the United States, where he first did some legal work and then embarked in the publishing business. The World War forced him out of the latter field of effort and led him to take up art and that particular department of it for which his native gifts peculiarly qualified him—that of sculpture.

While Mr. Piatta's portrait busts of prominent men have won him well-deserved praise, still the highest product of his creative skill is his design for the Navy and Marine Memorial which will be placed in Washington on a bank of the Potomac River. This memorial is a gift of the American people to the nation as an expression of gratitude to all those in the naval service that have given their lives in war and in peace upon the sea for the welfare and the protection of their country. It is singularly appropriate that the same genius should turn his talents to a work which is intended to promote security and welfare among a still greater body of men working for the national good.

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The first of a series of powerful lighthouses, which are to mark the route of the Paris-Algiers aircraft service, has been placed in commission on Mont Afrique, near Dijon, 1,800 feet above sea level. The light is of 874,000,000 candle power and will give a double-beam flash twelve times a minute. In the clearest weather it will be visible for 300 miles. This chain of French lighthouses will be an important aid in international long-distance night flying.

# Centenary of the Passenger-Carrying Steam Railway

By ARTHUR CHEW KARR

AMERICANS have every reason to be interested in the forth-coming centennial celebration of the institution of the passenger-carrying steam railway.

We have to pause only for a moment to recognize the momentous part which this system of transportation has played in the evolution of the United States. Our great empire of industry and our preëminent prosperity rest fundamentally upon that unity of interest which the railroads have brought about by their service throughout the length and breadth of the land.

Not only have these lines made it possible for us to open up virgin territory and to minimize the isolating effects of considerable distances, but these highways of steel have long constituted arteries through which have flowed in increasing measure, year by year, an unparalleled tide of essential commodities.

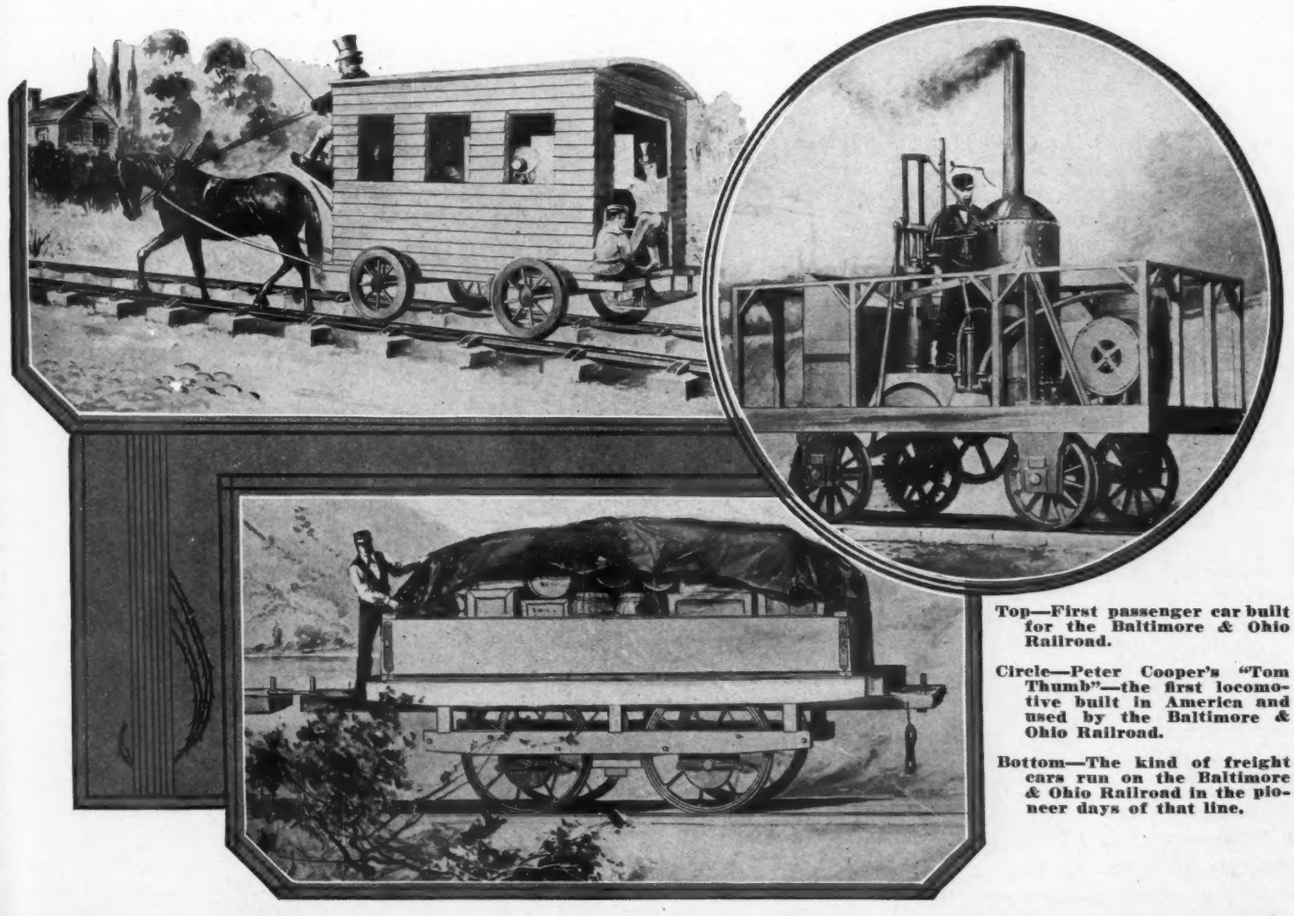
Just think of it, in 1830 we could boast but 23 miles of railways: today, we have a network of more than 250,000 miles of these lines which cover the country in every direction and make for ease of access and nation-wide intercourse. From doubtful experiments, carried out with less than a dozen locomotives of debatable mechanical virtues, we have developed a demand that calls for the services of nearly 70,000 locomotives—many of them of splendid proportions and capable of drawing unit trains of 3,000 tons and more at a lively clip. For the transportation of passengers we have in use 57,200 cars, and for the handling of freight we have an aggregation of approximately 2,400,000 cars.

**FEW who travel at high speed and in more or less luxurious trains throughout the wide expanse of the United States realize how great has been the advance in this method of transportation in the course of the last hundred years.**

**The first steam passenger train made its initial run in September of 1825; and it should be a matter of general interest to look back to the early days of steam railroading in order that we may have some conception of what has been achieved since then.**

The foregoing figures are mentioned merely to emphasize why we should hark back to September 27, 1825, when the Stockton & Darlington Railway in England was formally opened to passenger service. For that memorable undertaking, the road was equipped with a single engine curiously named *Locomotion No.* 1. Authority to embark upon that sort of traffic was given the line by a parliamentary act, two years earlier, which empowered the company "to make and erect . . . loco-motive or movable engines . . . and to use and employ the same in and upon the said railways or tramroads. . . ."

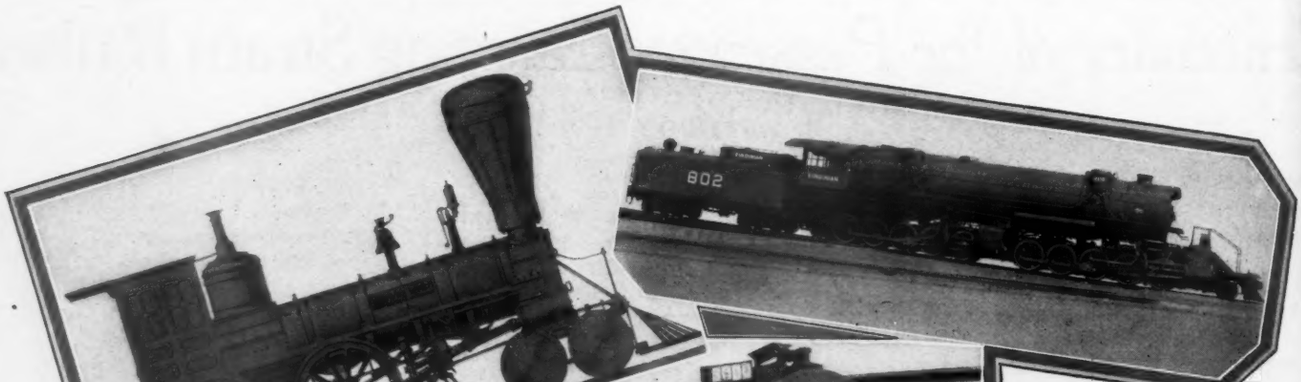
*Locomotion No.* 1 weighed 6½ tons, light; carried a steam pressure of 25 pounds; and is said to have been able to draw 90 tons at the rate of 12 miles an hour. It was designed by George Stephenson, and built in Newcastle in the works established by him under the firm name of Robert Stephenson & Company. As we know, the early development of the steam locomotive owed much to the inventive genius



**Top—First passenger car built for the Baltimore & Ohio Railroad.**

**Circle—Peter Cooper's "Tom Thumb"—the first locomotive built in America and used by the Baltimore & Ohio Railroad.**

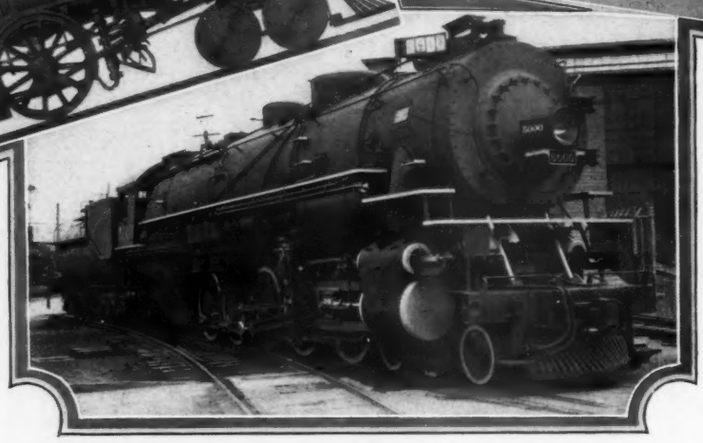
**Bottom—The kind of freight cars run on the Baltimore & Ohio Railroad in the pioneer days of that line.**



Giant freight engine built by the American Locomotive Company for the Virginian Railroad. This engine develops a tractive power of 176,600 pounds.



"Governor Marcy," built by the Schenectady Locomotive Works in 1851 for the Michigan Southern Railroad.



One of the 5,000 Class, 3-cylinder locomotives built for the Southern Pacific Railroad by the American Locomotive Company. An engine like this is intended for fast freight service and, together with its tender, weighs 685,000 pounds.

of George Stephenson who, in 1814, produced his first locomotive as a consequence of a boast that he could turn out something better in this field than the engine evolved by his pioneer rival, Blenkinsop.

Blenkinsop's locomotive was designed to draw 70 tons at a speed of 3 miles an hour. The engine did its work; but Stephenson was not favorably impressed by its performance, and is said to have remarked: "I think I could make a better engine than that to go upon three legs." In a way, he achieved this. He managed to secure the monetary aid of Lord Ravensworth in building a traveling engine. That locomotive was completed and ready for testing in July of 1814, and was able to draw a load of 30 tons up a gradient of 10 feet to the mile and attained a velocity of 4 miles an hour. Even so, Stephenson's critical eye discovered many defects in his engine, and he realized that he would have to do still better to achieve commercial success because the cost of operating that locomotive was just about as great as when horses were used for traction.

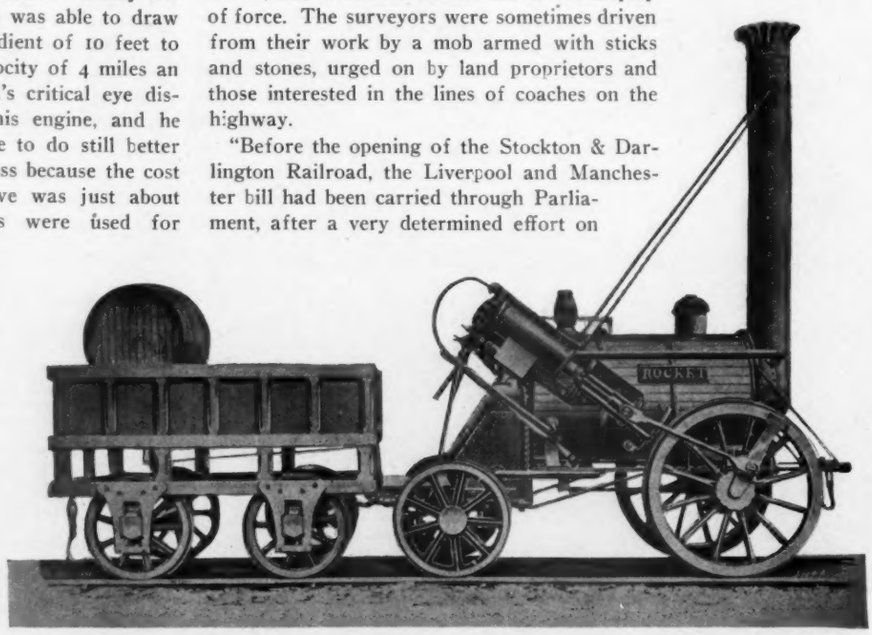
Skipping over the various steps by which Stephenson advanced in evolving practical types of locomotives, we come to 1823 when he became the engineering expert for the Stockton & Darlington Railroad—a line then being projected primarily to put the valuable coal lands of Durham in touch with tidewater. Professor Robert H. Thurston has given an interesting picture of that period in the history of British steam railways. According to this American authority:

"A railroad between Manchester and Liverpool had been projected at about the time that the Stockton & Darlington road was commenced. The preliminary surveys had been made in the face of strong opposition, which did not always stop at legal action and verbal attack, but in some instances led to the display of force. The surveyors were sometimes driven from their work by a mob armed with sticks and stones, urged on by land proprietors and those interested in the lines of coaches on the highway.

"Before the opening of the Stockton & Darlington Railroad, the Liverpool and Manchester bill had been carried through Parliament, after a very determined effort on the part of coach proprietors and landholders to defeat it, and Stephenson urged the adoption of the locomotive to the exclusion of horses. It was his assertion, made at this time, that he could build a locomotive to run 20 miles an hour that provoked the celebrated rejoinder of a writer in the *Quarterly Review*, who was, however, in favor of the construction of the road and of the use of the locomotive upon it: 'What can be more palpably absurd and ridiculous than the prospect held out of locomotives traveling twice as fast as stage coaches? We would as soon expect the people of Woolwich to suffer themselves to be fired off upon one of Congreve's ricochet rockets as trust themselves to the mercy of such a machine going at such a rate.'

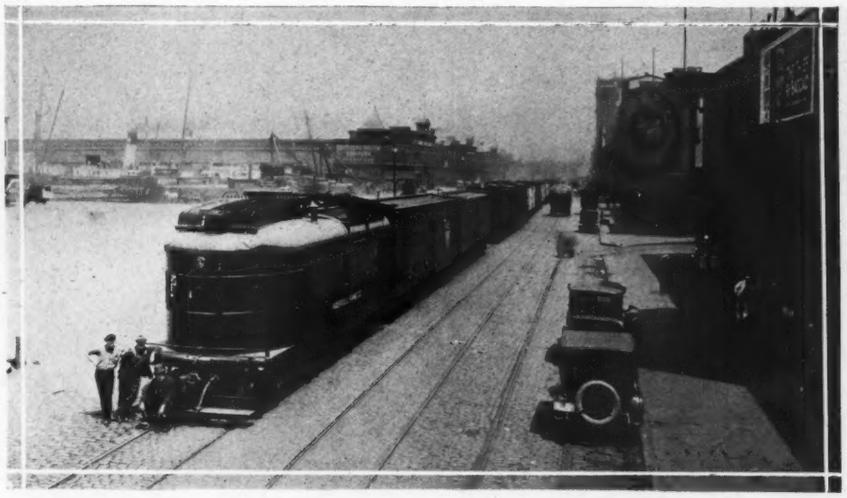
"It was during his examination before a committee of the House of Commons, during this contest, that Stephenson when asked, 'Suppose, now, one of your engines to be going at the rate of nine or ten miles an hour and that a cow were to stray upon the line and get in the way of the engine; would not that be a very awkward circumstance?' replied, 'Yes, very awkward—for the coo!' And when asked if men and animals would not be frightened by the red-hot smokestack, answered: 'But how would they know that it was not painted?'"

The way of the partisan of the steam locomotive in the "twenties" of the nineteenth century was full of rough going, because the directors of many of the railroad




George Stephenson of England built this locomotive 94 years ago to pull the first passenger trains on the Stockton & Darlington Railway. Thousands of people then doubted that rail service of that sort could be maintained without gravely menacing the safety and the comfort of the public.

enterprises of that time were wedded to the horse for traction purposes, and the visible evidences of the benefits to be gained by the adoption of the steam engine made but little impression upon those conservative men. This was the case when the Newcastle & Carlisle Railroad was built in 1828.



**The Oil-electric locomotive—the newest form of self-contained power unit—is a revolutionary development in railroad engineering. This type of locomotive has been developed jointly by the General Electric Co., The American Locomotive Co., and the Ingersoll-Rand Co.**

However, Stephenson gained a concession—he was allowed to put on the line a single locomotive to be used in hauling gravel trains during the period of construction. Some months later, by reason of earnest pleading and persistent opposition to the adoption of the horse, the authorities of that railroad finally decided "to give the traveling engine a chance." A reward of £500 was offered for the best locomotive engine; and the following requirements were specified:

"1. The engine must consume its own smoke.

2. The engine, if of six tons weight, must be able to draw after it, day by day, twenty tons weight (including the tender and water tank) at ten miles an hour, with a pressure of steam on the boiler not exceeding fifty pounds to the square inch.

3. The boiler must have two safety valves, neither of which must be fastened down, and one of them completely out of control of the engineman.

4. The engine and boiler must be supported on springs, rest on six wheels, the height of the whole not exceeding fifteen feet to the top of the chimney.

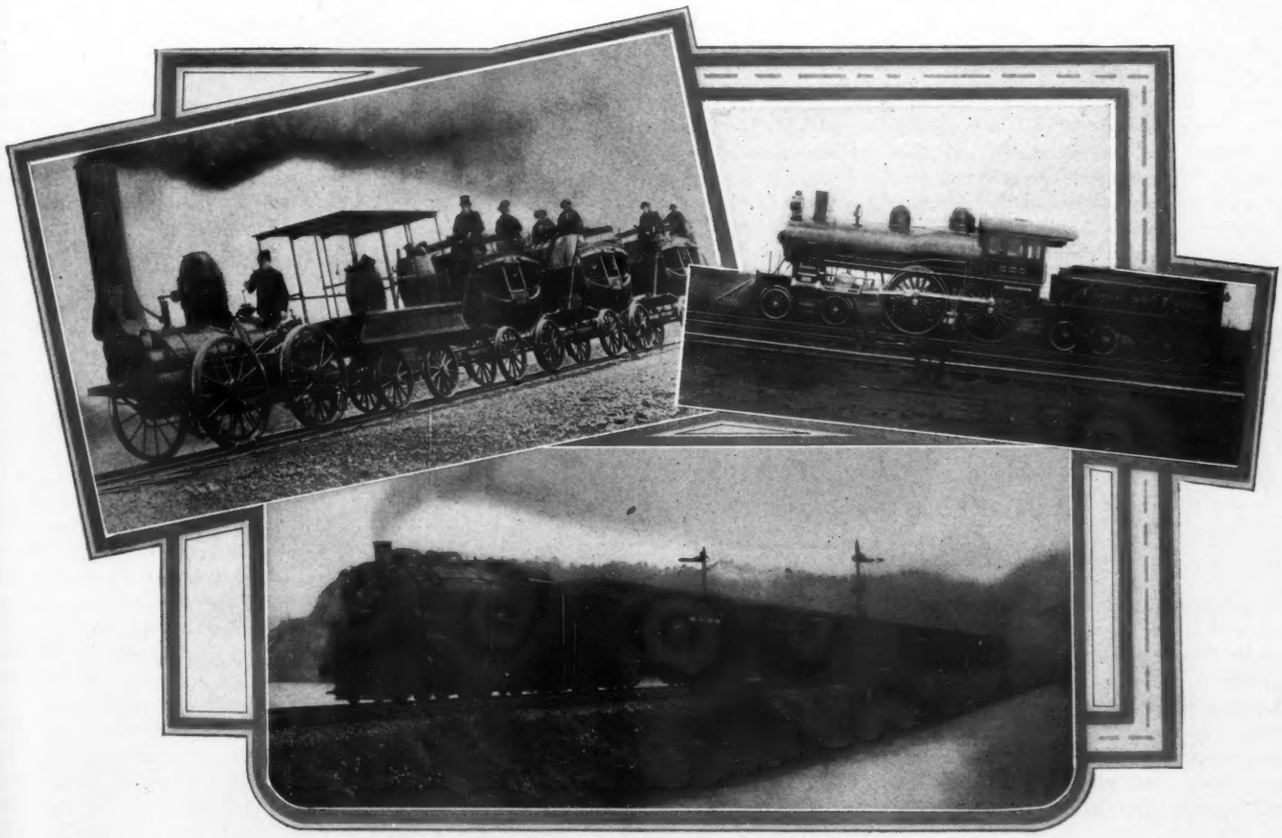
5. The engine, with water, must not weigh more than six tons; but an engine of less weight would be preferred, on its drawing a proportionate load behind it; if only 4½ tons, then it might be put only on four wheels. The company to be at liberty to test the boiler, etc., by a pressure of 150 pounds to the square inch.

6. A mercurial gauge must be affixed to the machine, showing the steam pressure above forty-five pounds to the square inch.

7. The engine must be delivered, complete and ready for trial, at the Liverpool end of the railway not later than October 1, 1829.

8. The price of the engine must not exceed £550."

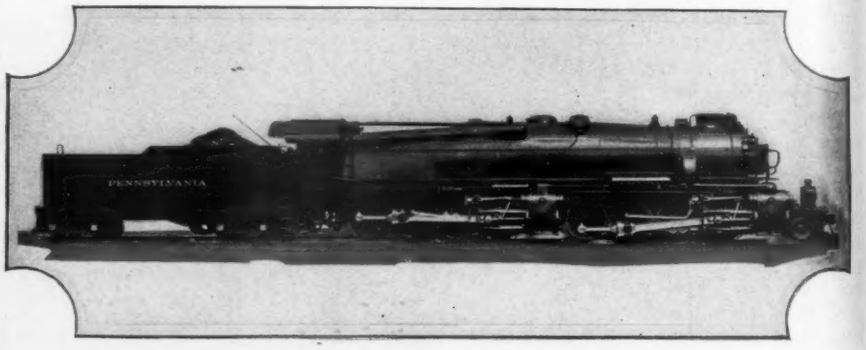
Only four locomotives were submitted for the test. Out of them but two survived in



**Left—The "DeWitt Clinton," the third locomotive built in the United States for actual service, made its maiden run on the Mohawk & Hudson Railroad in 1831.**
**Right—The famous "999," which was placed in service in 1893 and shattered all speed records by making a run at the rate of 112 miles an hour.**
**Bottom—The "Twentieth Century Limited," which now makes daily runs over the New York Central Railroad and covers the distance of 900 miles between New York and Chicago in 20 hours.**

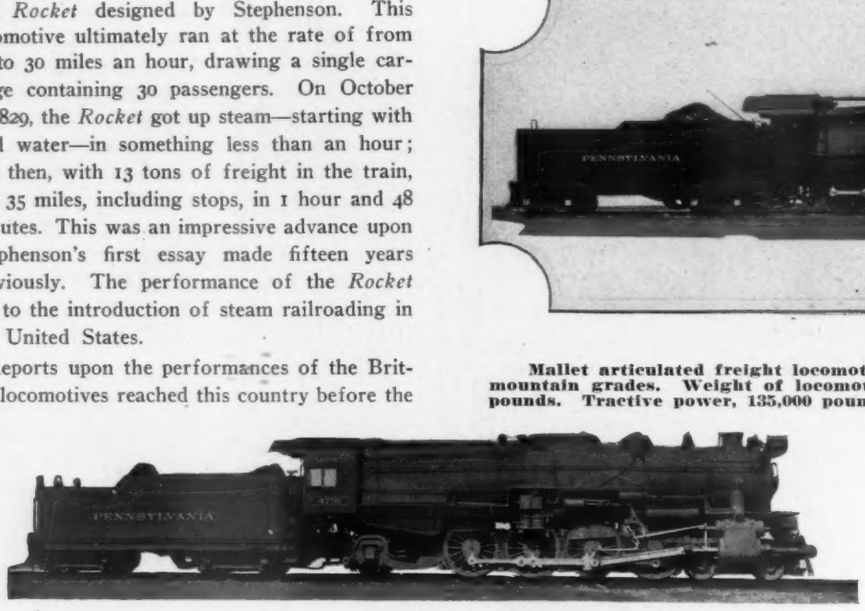
the end; and between these victory went to the *Rocket* designed by Stephenson. This locomotive ultimately ran at the rate of from 25 to 30 miles an hour, drawing a single carriage containing 30 passengers. On October 8, 1829, the *Rocket* got up steam—starting with cold water—in something less than an hour; and then, with 13 tons of freight in the train, ran 35 miles, including stops, in 1 hour and 48 minutes. This was an impressive advance upon Stephenson's first essay made fifteen years previously. The performance of the *Rocket* led to the introduction of steam railroading in the United States.

Reports upon the performances of the British locomotives reached this country before the close of 1829, and Horatio Allen, afterwards president of the Novelty Works in New York City and the first American to run a locomotive in this country, was asked to advise the South Carolina Railway Company as to the wisdom of employing steam power instead of horse traction. Mr. Allen had been in England and had witnessed the trials of the *Rocket*. He declared that the engine was gaining favor over the horse, "on the broad ground that in the future there was no reason to expect any material improvement in the breed of horses, while, in my judgment, the man was not living who knew what the breed of locomotives was to place at command."




Courtesy, Pennsylvania Railroad.

**Mallet articulated freight locomotive, constructed in 1919 for pusher service on mountain grades. Weight of locomotive and tender, in working order, 822,500 pounds. Tractive power, 135,000 pounds.**




Courtesy, Pennsylvania Railroad.

**Mountain type passenger locomotive of 1923, built to meet the demands of heavy express passenger service. Weight of locomotive and tender, in working order, 559,600 pounds. Tractive power, 64,550 pounds.**

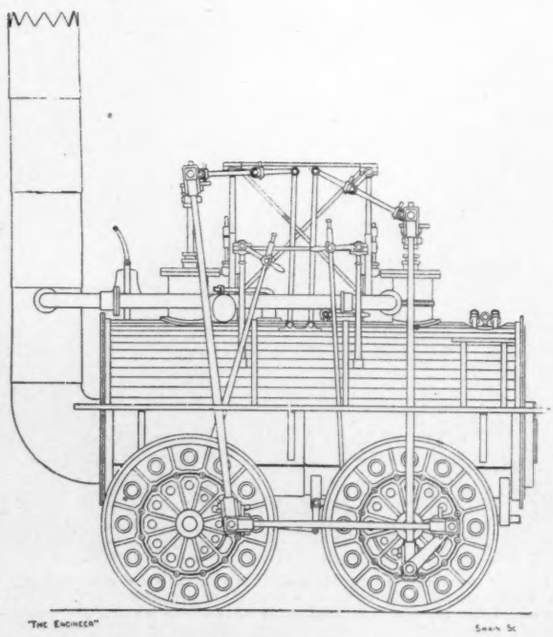
Between 1829 and '30, Peter Cooper of New York experimented on the tracks of the Baltimore & Ohio Railroad with a little locomotive known as *Tom Thumb*. It was the first engine for that purpose built in America. At a meeting of the Master Mechanics Association, in 1875, Mr. Cooper related with great glee how, upon one of those trial runs, he actually beat a gray horse attached to another car. While the Baltimore & Ohio Railroad was chartered in 1827, still steam as a motive power on rails was an untried venture in this country; and so far as locomotion over the original fourteen miles of that line was concerned, the founders had to be satisfied at first with horses and trials made even with dogs. For a little while the managemnet tested the "sail car," and for a brief span that application of the wind to propulsion was deemed wonderful.

In 1831, the Baltimore & Ohio offered a prize of $4,000 for "the most approved engine to be delivered for trial on or before June 1, 1831, and $3,500 for the engine next best." It was stipulated that the locomotive should not exceed 3½ tons in weight and that it should be able on a level road to pull day by day a load of 15 tons, inclusive of the weight of wagons, at a speed of 15 miles an hour. But three locomotives were submitted in competition, and only one of them proved capable of useful service. That engine, named *York*, was built in York, Penn., and constructed after the design of Phineas Davis, a member of the firm of Davis & Gartner.

Although by training and business a watch and clockmaker, Davis builded well; and the *York* was the forerunner of the grasshopper type of locomotive used for years afterwards with satisfaction by the Baltimore & Ohio Railroad. The *Atlantic*, turned out in 1832, was of the same kind. Strange as it may seem, a silversmith laid the foundation for the upbuilding of one of our greatest companies engaged in the production of modern locomotives. We refer to Matthias W. Baldwin. In 1819, Mr. Baldwin started out on his own account with a small shop to pursue his craft; but trade slackened in the course of the following six years. Then, to make a livelihood, he entered into partnership with David Mason, a machinist, and started to manufacture tools for bookbinders and cylinders for calico printing.

That business went along so well that steam power was needed, and so an engine was bought. Somehow it proved unsatisfactory, and Mr. Baldwin set about designing and constructing an engine to meet his shop requirements. The limited space available necessitated the construction of an engine that would occupy small floor space, and to meet those conditions Mr. Baldwin evolved an upright engine of novel and ingenious pattern. Being the product of a jeweler, its workmanship was excellent and its performance no less so. As a result of that success, outside orders were received for stationary engines, and the business grew apace. This experience blazed the way for still another line of mechanical endeavor.

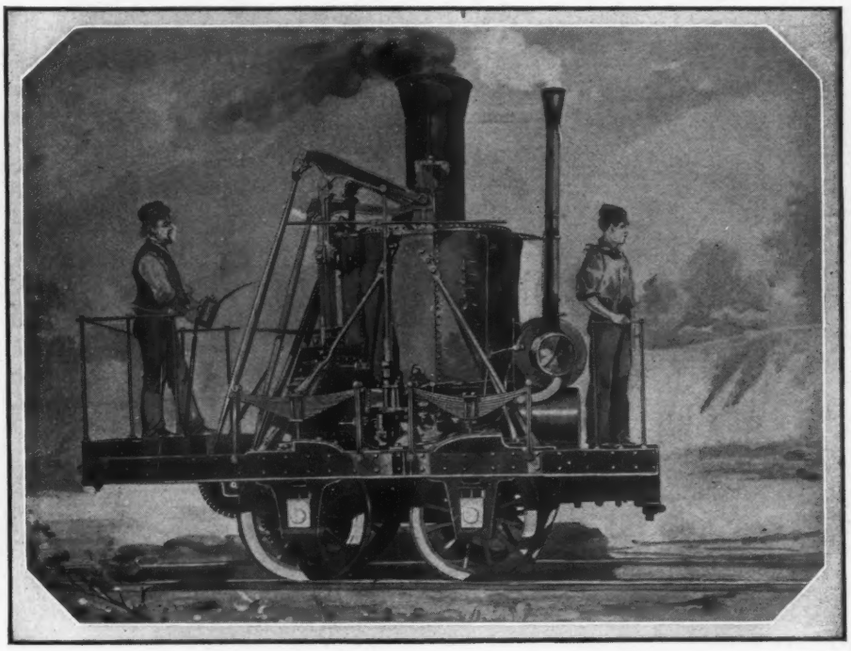
Early in 1831, Mr. Franklin Peale, then the proprietor of the Philadelphia Museum, asked Mr. Baldwin to construct a diminutive locomotive for exhibition purposes. With nothing to guide him but the rather imperfect descriptions and sketches of the locomotives submitted in the Rainhill competition in England sometime before, Mr. Baldwin essayed the task and produced by April of that year a locomotive which could be run on a circular track of pine boards, covered with hoop iron, which was laid in one of the rooms of the museum. Two small cars, containing seats for four passengers, were attached to the engine; and both anthracite and pine-knot coal were used as fuel. The exhaust steam was discharged into the




**"Locomotion No. 1"**

smokestack to increase the draft. The outfit attracted admiring crowds.

The next step in the career of this fertile-minded man led shortly afterwards to the construction of a steam locomotive for the 6-mile horsepower railway operated between Philadelphia and Germantown. Notwithstanding the lack of proper tools for the work, and despite the fact that he had to do much of the work himself while training others to be of assistance to him, Mr. Baldwin overcame well-nigh insuperable difficulties and had ready for trial on November 23, 1832, the locomotive known as *Old Ironsides*. Mr. Baldwin received $3,500 for that engine; and we have the following contemporaneous account of that locomotives's initial run:



**This so-called "grasshopper engine," known as the "Atlantic," was built in 1832 for the Baltimore & Ohio Railroad. It weighed 6½ tons, and was able to haul 50 tons over gradients having a maximum rise of 37 feet to the mile at a speed varying from 12 to 15 miles an hour.**

"The engine, with her tender, moved from the depot in beautiful style, working with great ease and uniformity. She proceeded about half a mile beyond the Union Tavern, at the township line, and returned immediately —a distance of 6 miles—at a speed of about 28 miles to the hour. . . . Needless to say, the spectators were delighted. From this experiment there is every reason to believe this engine will draw 30 tons gross, at an average speed of 40 miles an hour, on a level road." Subsequently, *Old Ironsides* attained a speed of 30 miles an hour when drawing its usual train.

The success of that engine led to the following advertisement in *Poulson's American Advertiser* during November of 1832:

"Notice—The locomotive engine (built by M. W. Baldwin of this city) will depart daily, when the weather is fair, with a train of passenger cars, commencing on Monday, the 26th instant. . . . The cars drawn by horses will also depart as usual, . . when the weather is not fair." Such was the state of steam traction in this country 93 years ago!

## FLOATING ISLANDS IN THE ATLANTIC

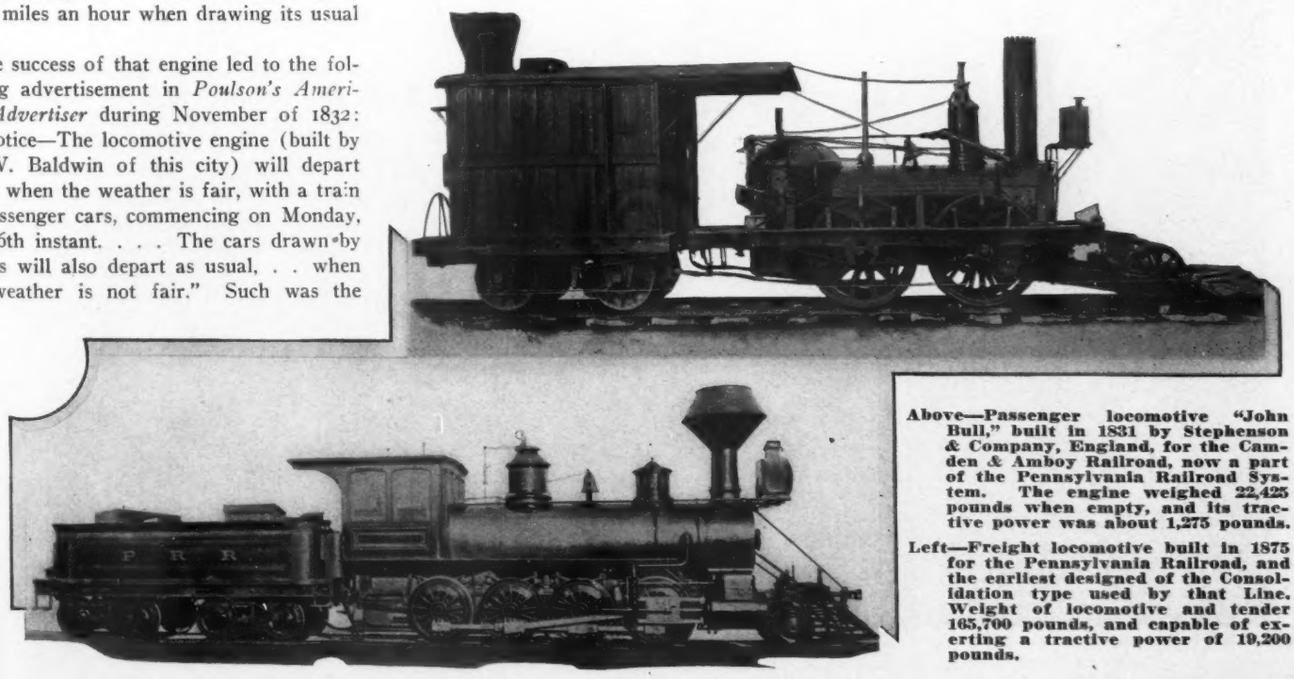
IT is proposed by the French to provide four floating islands in the Atlantic, to serve as bases for aerial transport, 450 yards long and 230 yards wide, at a cost of 200 million francs each. It is impossible to consider the proposition very seriously, on account of the enormous cost, the difficulty of holding the "islands" in position and the constant menace to navigation.

Leading sheep or goats up to the front door for milking is said to be a common enough practice in places in Europe. And now it looks as if ice is to be made to order at your door-step. An Austrian firm has produced an ice-making vehicle on which a vertical compressor is placed behind the chauffeur's seat. This car is provided with an automobile benzine motor so that the plant can be operated when the vehicle is standing as well as when moving.

Canadian trade authorities have recently reported that successful tests have been made with Alberta straw for the manufacture of paper.

## WHOLESALE FARMING

A FARMING corporation in Montana now cultivates 72,000 acres, using only power machinery and not a horse in sight. Fourteen tractors plow and seed a square mile of grain a day, and, when it comes to harvesting, a single tractor, pulling six binders, cuts 150 acres a day. Next year the corporation expects to produce 1,000,000 bushels of grain.




**Above—Passenger locomotive "John Bull," built in 1831 by Stephenson & Company, England, for the Camden & Amboy Railroad, now a part of the Pennsylvania Railroad System. The engine weighed 22,425 pounds when empty, and its tractive power was about 1,275 pounds.**

**Left—Freight locomotive built in 1875 for the Pennsylvania Railroad, and the earliest designed of the Consolidation type used by that Line. Weight of locomotive and tender 165,700 pounds, and capable of exerting a tractive power of 19,200 pounds.**

# Air-Driven Drills and Riveting Hammers


These tools are used in constructing steel freight cars.

# Ingenious Traveling Cantilever Beam Used In Widening Out Moffat Tunnel

By JAMES F. COHIG*

IN previous issues, work on the Moffat Tunnel has been described in some detail. It will be recalled that the pioneer tunnel in the main or railroad tunnel is subsequently enlarged to the full prescribed size after the heading has been advanced anywhere between 500 and 1,000 feet.

Owing to the soft nature of much of the rock encountered in pushing forward from the west portal, extensive timbering has been required to support the roof and the side walls at various stages during and after widening operations. As can be readily grasped, much resourcefulness and much labor have been involved in the successful execution of this work which has called for skilful shifting of timbers and transferring of the load from one set of supports to another.

The mucking incident to widening out the railroad tunnel and the removal of the bench has been done by a large air shovel which has needed ample room to perform effectively. At the start, the wall plates and the encumbent timber were supported by means of rakers and also by means of I-beams supported from longitudinal girders which, in their turn, were carried on the wall plates above the bench and on cross members on the wall plates of the completed tunnel. Both of these schemes offered considerable difficulties. The rakers interfered with operations and were not always to be depended upon to hold the wall plates in position. The beams were inadequate, slow in movement, and did not hold the wall plates out.

In a particularly bad piece of ground it was found necessary to discard both of these schemes, and the bench was advanced in two sections, each about nine feet in height. Hand mucking was necessarily resorted to, with the use of numerous rakers. The uncertain performance of the ground made this method somewhat hazardous; and the wall plates continued to move inward with each operation. Progress was necessarily slow—that is to say, the advance was about six feet per day of 24 hours; and the excavating cost was considerably higher than when the mucking was done by air shovel.

To meet the situation more effectually and more economically, Mr. George Lewis, General Manager for the Moffat Tunnel Commission, designed and built a traveling cantilever beam capable of holding the wall plate up and out. This beam provides sufficient clearance to permit the use of the air shovel for mucking, and thus reduces the cost of the work and speeds up daily progress. This beam consists essentially of two parallel 3½-foot plate girders 60 feet long, spaced 6 feet on centers, provided with the necessary cross-frames and lateral bracing. Adjustable hangers, carrying movable arms, support the wall plates and hold the head end of the girder on the track.

**The Lewis traveling cantilever beam in service in the Moffat Tunnel.**

The girders are moved forward on special cast-steel dollies arranged as shown in the accompanying sketch. These dollies roll on 2 pairs of steel channels, 12 inches wide, laid flanges down upon 12x12 Oregon fir stringers. This track is arranged in 10-foot sections to facilitate moving. Where the upper half of the bench has been removed the track is moved forward on cribbing. Considerable care is exercised in laying the track to secure proper line and grade. The clearance is limited, as a material variation would cause the girder or parts of the outrigging to bind against the surrounding timber lining. For reference purposes, the end pointed into the tunnel will be called the head end.

Under normal conditions, Dollie A is in operation and acts as the fulcrum of the cantilever. The footing and the bench on a 1 to 1 slope use about 13 feet of the 25-foot overhang, leaving a clear 12 feet of bench which may be removed without in any way hazarding the support of the girder. If, however, the face of the bench should run or slough and the track should fall out from under A, then the load would be carried by B, and operations could proceed under the rear of the beam. Should this occur, the beam when free, as in moving, would be overbalanced. This is provided for by having a platform in the forward end that can be loaded and counterbalance the beam.

An air hoist is located at the head end of the beam providing movement. A line from this hoist is carried ahead, through blocks, and secured to a cross timber some 150 feet forward of the beam. Considerable dexterity has been developed by the crew in guiding the beam by shifting the position of the fastening on the cross timber.

Four hangers and arms, two on a side, are used at the head end under the wall plates to balance the beam when it is in operation. These are supplemented by jacks, on the top of the beam, which are loaded against the back of the tunnel. Under ordinary conditions of operation the jacks provide sufficient thrust to balance the beam.

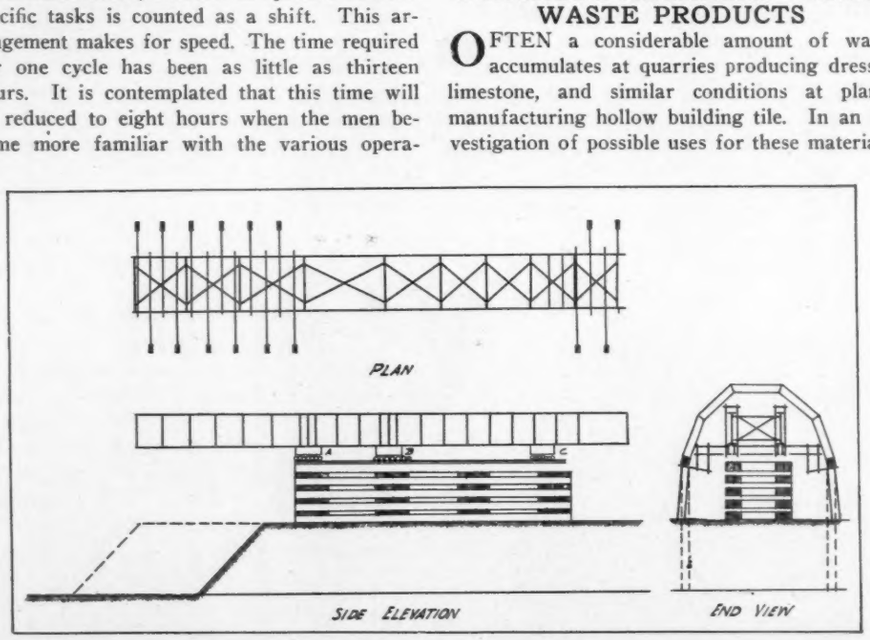
The rear overhanging part of the beam carries twelve hangers, six on a side. These may be moved lengthwise on the beam to meet the centering requirements of the timber. These arms are moved under and are wedged against the wall plates, holding them out by means of a hole-and-pin arrangement. The arms are raised in a vertical direction to a supporting tightness under the wall plates by wedge-

*Assistant Engineer, Moffat Tunnel Commission.

type jacks under the upper part of the hanger on the girder nearest the wall plate being supported. Rings in the ends of the projecting arms provide convenient supports for blocks, over which the posts can be hoisted to position under the wall plates.

When the girder is being moved into position and the arms are extended and wedged the bench is drilled. As soon as the beam is taking the weight of the wall plates, the temporary timber under the wall plates is removed and the bench is shot and mucked. Sufficient posts are placed and wedged under the wall plates to support them temporarily. The beam is then moved forward. A follow-up crew fills in the necessary timber. This completes the cycle of operations.

The girder is moved by a special, trained crew. These men and the shovel operators work when called, and the completion of their specific tasks is counted as a shift. This arrangement makes for speed. The time required for one cycle has been as little as thirteen hours. It is contemplated that this time will be reduced to eight hours when the men become more familiar with the various operations. In any tunnel employing wall plates—a real construction advantage—the recognized weak point is the wall plate, itself. The cross-fiber strength of the timber is the limiting factor, and is about one-fourth of the strength parallel to the grain. Using an I-beam for the wall plate would remedy this and give the same strength as when utilizing individual ribs without a wall plate. With the methods in common use in tunneling this would be impossible on account of the lack of rigidity of such a structural member when laid flat, but with the cantilever beam described it is possible to place supports under such a wall plate on sufficiently short centers to overcome the difficulty. It is expected that the cantilever beam will prove especially useful with this type of construction




**Essential features of the Lewis traveling cantilever beam.**

## CONCRETE AGGREGATE FROM WASTE PRODUCTS

OFTEN a considerable amount of waste accumulates at quarries producing dressed limestone, and similar conditions at plants manufacturing hollow building tile. In an investigation of possible uses for these materials, the Bureau of Standards recently carried out a few tests on concretes—employing the waste as coarse aggregates.

Forty-five 6x12-inch test cylinders were made in which Potomac River sand was used as fine aggregate. In one-third of these cylinders, Potomac River gravel, and tile and limestone waste were utilized as coarse aggregate. Three proportions by volume, 1:2:4, 1:2½:5, and 1:3:6, were used for each coarse aggregate. This was crushed, and only that proportion between the No. 4 and the 1½-inch sieves was used. All mixes were brought to the same flow of 90, as measured by the flow table. To obtain these flows the amount of water by weight of the total dry materials was 9.7 per cent. for the gravel aggregate, 13.8 per cent. for the limestone aggregate, and 15.4 per cent. for the tile aggregate.

The specimens were stored in the damp closet, and were tested at the age of 28 days. For the gravel concrete, the strengths developed by the 1:2:4, 1:2½:5, and 1:3:6 mixes, respectively, were 1,680, 1,185, and 835 pounds per square inch; for the tile concrete, the corresponding strengths were 2,070, 1,328, and 957 pounds per square inch; and for the limestone concrete they were 1,525, 972, and 777 pounds per square inch.

The results of the tests indicate that in so far as strength is concerned these waste products are suitable for coarse aggregates in concretes. However, both materials produced rather harsh working mixes as compared with the gravel mixes; and in order to insure ease of handling and of placing these concretes it probably would be well to use over-sanded mixes.

## WHICH SIDE OF BELTING IS MORE EFFICIENT?

IN an effort to determine the respective efficiencies of the grain and the flesh sides of leather, the Leather Belting Exchange has made a series of tests in its research laboratory at Cornell University. These tests clearly indicate that under ordinary shop conditions the flesh side will transmit only from 50 to 60 per cent. as much horse power as the grain side. However, at higher tensions, the flesh side will average from 50 to 100 per cent. as much as the grain side—the efficiency depending, of course, on the belt, the tension, and the conditions of service.

## DEEP SEA DIVER NEARLY KILLED BY THE HEAT

IN the intensely hot spell of the first week of June, a deep-sea diver very narrowly escaped death from the heat forty feet below the surface of the Delaware river near Philadelphia. He went down to make some repairs on the supports of a dock, and in less than twenty minutes "everything went black to him" and he became unconscious before he could signal. When brought to the surface a half an hour later very strenuous exertions were required to revive him. The air pump, upon which his life depended, had been exposed to the heat of the sun all day, and the temperature of the air sent down to him and filling his diving suit is supposed to have been above 115 degrees.

## AIRPLANE TO SERVE A MINE

A LINCOLN Standard biplane equipped with a Hispano-Suitz motor of 110 H.P., designed for high altitudes and to carry heavy loads with a quick takeoff, has been adopted, as we learn through *Nevada Mining Press*, for the regular service of the Silverado Mine of the Mono Mining Co. of Nevada. It will be an important feature of the transportation system of the mine, which is 60 miles from a railroad, promising a big saving of time, especially in emergencies when some vital item of equipment is required. Suitable landing places are being provided at the points where needed. The home-landing field is at an elevation of 6,000 feet.

According to the latest official census, that for the year 1924, Japan has a total population of 59,138,900—the increase being at the rate of 750,000 per annum.

# Denver Growing as an Engineering Center

## Important Part Played in This Development by Thomas B. Stearns

By THE STAFF

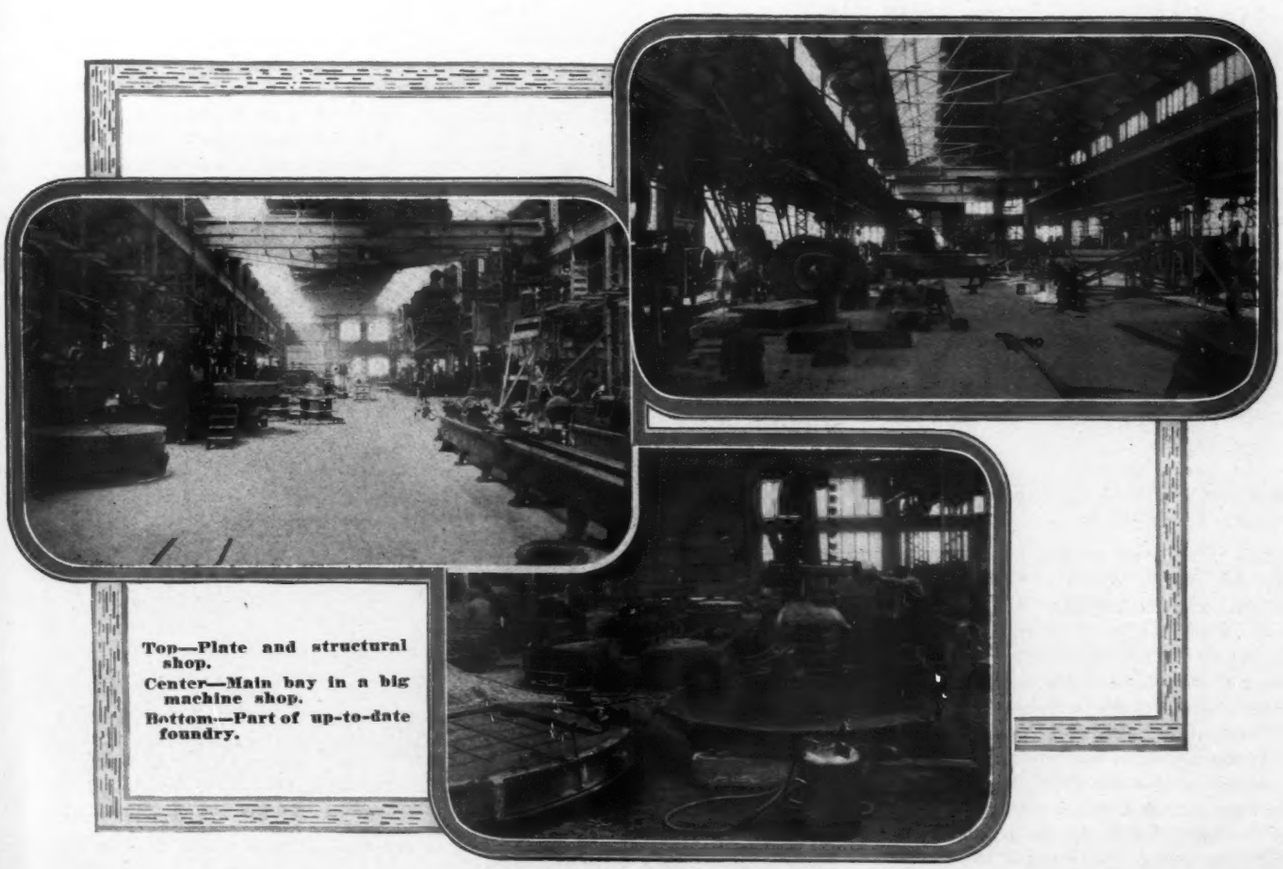
WITH a view to taking still better care of the machinery needs of Colorado's steadily expanding industrial life, there has recently been organized the General Iron Works Company—an aggregation of long-established and well-known Colorado enterprises which have played a conspicuous and valuable part in providing locally for the mechanical needs of the state. Before dealing with this new organization, which is of great potential promise to the region, let us go back four decades to the beginning of the things that have so largely influenced the formation of the General Iron Works Company. Here, as is so often the case, we see what the guiding hand of one strong man can achieve in directing the energies of others.

On October 3, 1859, Thomas B. Stearns was born in Brooklyn, N. Y. Eighteen years later he was graduated from the Brooklyn Polytechnic Institute, and in 1881 he won his diploma from the Columbia School of Mines. In 1883 he established himself permanently in Colorado; and between 1881 and 1885 he devoted his time to examining and to operating mining properties and to familiarizing himself with the needs of the mining country. With this background of contact and practical service, Mr. Stearns became the inspiration which called T. B. Stearns & Company into being in 1885. The company, which was organized in Denver, consisted of Mr. Stearns and two expert accountants—both of English origin—who were closely connected with several large mines in Colorado. The business of the firm was to furnish machinery and supplies to mining companies operating in the state.

**NO other state, with the exception of California, has so wide a range of mineral resources as Colorado. Somewhere and in notable measure, the Centennial State can duplicate nearly every useful mineral found elsewhere within our boundaries.**

**While the mines of Colorado have yielded wealth to the value of substantially $2,000,000,000 since 1858, other resources of the state and industries of divers kinds have been increasingly productive; and the day is surely coming when the state will loom large as a manufacturing center for a vast region lying in neighboring states. This fact gives point to the accompanying story.**

In 1886, the firm name was changed to Stearns, Roger & Company. At that time the expert accountants retired and John Roger, a Scotch engineer, succeeded them. The new company amplified its business to the extent of undertaking contracts for the building of plants and mine tramways and for the equipping of new companies. Stearns, Roger & Company prepared the plans and supervised the construction of the original Holden Smelting Company—afterwards the Globe Smelting & Refining Company of Denver, Col., and later for the Philadelphia Smelter at Pueblo, Col., which was the first smelting enterprise undertaken by the Guggenheim family. Stearns,

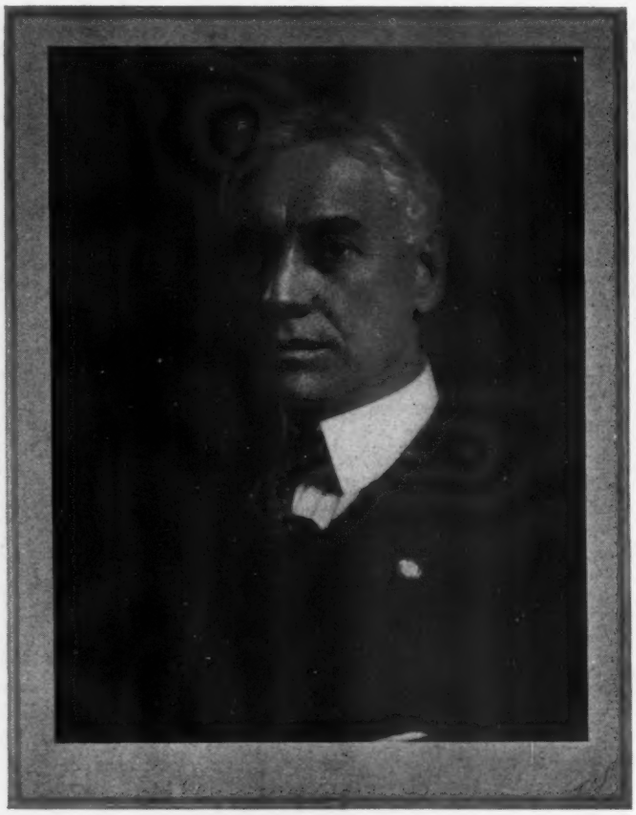


**Top—Plate and structural shop.**
**Center—Main bay in a big machine shop.**
**Bottom—Part of up-to-date foundry.**

Roger & Company also designed and erected throughout Colorado a number of electric light and power stations. In the course of its activities, the firm leased shops in Leadville, known as the Excelsior Iron Works, and operated the plant for two years —1888 and 1889.

In 1889, Stearns, Roger & Company created in the City of Pueblo a plant consisting of a machine shop, a boiler shop, a foundry, etc., so that the firm would be able to do many kinds of engineering or mechanical work. At that time there was reason to believe that Pueblo would become the manufacturing center of that section of the West. During 1889, Stearns, Roger & Company became the agents for the Ingersoll-Sergeant Drill Company.

The Stearns-Roger Manufacturing Company was incorporated in 1891. The new firm continued its identification with the Ingersoll-Sergeant Drill Company and later became the representatives of the Ingersoll-Rand Company, which succeeded the Ingersoll-Sergeant Drill Company. The Stearns-Roger Manufacturing Company now represents a number of other well-known eastern manufacturers.



**Thomas B. Stearns.**

Until about twenty years ago, mining was the chief industry in Colorado and the neighboring states; and up to that time The Stearns-Roger Manufacturing Company devoted its energies mainly to engineering and manufacturing work connected with that industry. However, as mining became less and less predominant and other industries developed, the company found new channels for service. Today, the products either made by the company or handled by it are in use in many fields other than mining, such as beet-sugar plants, oil refineries, cold-storage and refrigerating plants, work in connection with irrigation, railroading, and roadbuilding, and the construction and equipping of power houses. The following plants built by the company give a good idea of the magnitude of the tasks which it is today prepared to deal with:

| | Cost |
|---|---|
| Burlington shops near Denver | $2,500,000 |
| Delta sugar factory | 1,500,000 |
| Garden City sugar factory | 1,000,000 |
| Portland Gold Mining Company's mill | 450,000 |
| General Iron Works' shops | 1,000,000 |

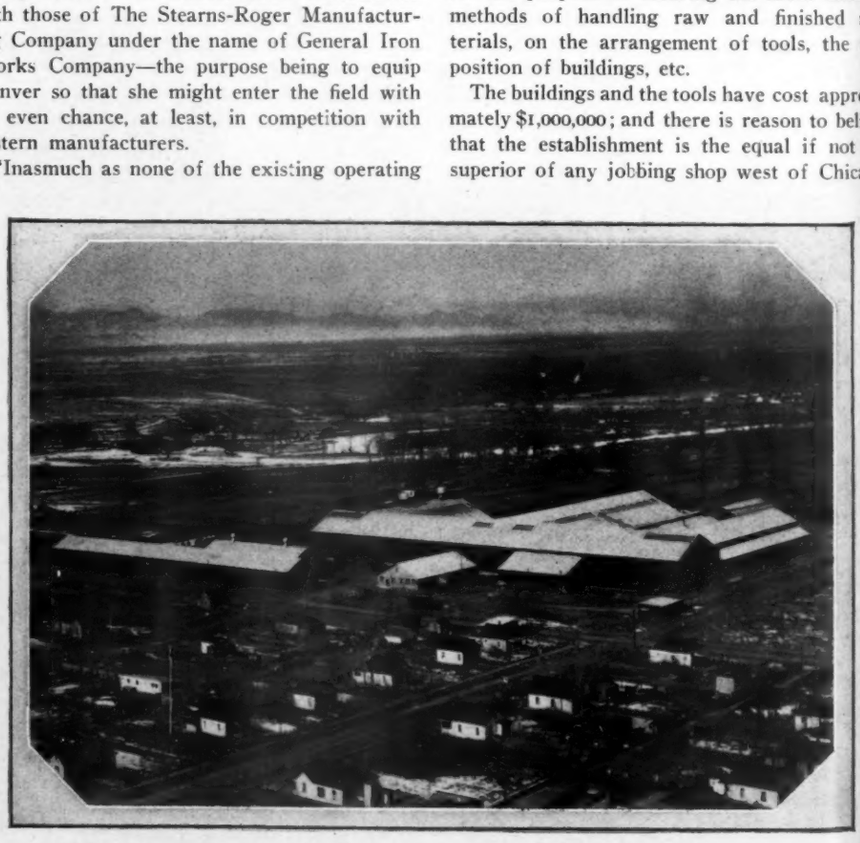
On June 2, 1921, the Fountain River, flowing past the Pueblo Works of The Stearns-Roger Manufacturing Company, overflowed its banks as the result of a cloudburst and swept away many of the buildings and much of the equipment of the plant. Inasmuch as the company's general offices are situated in Denver, and in view of the catastrophe at Pueblo, it was decided to establish new works in Denver.

It appeared unwise to add just one more plant to those already existing within the limits of the state capital and, therefore, after considerable negotiating the manufacturing interests of only the larger machine-manufacturing concerns in Denver were consolidated with those of The Stearns-Roger Manufacturing Company under the name of General Iron Works Company—the purpose being to equip Denver so that she might enter the field with an even chance, at least, in competition with eastern manufacturers.

"Inasmuch as none of the existing operating plans had either sufficient space or the necessary equipment to do the work for all the associated concerns, it was decided to provide room for expansion by erecting new shops. In the meanwhile, in order to make sure that the general scheme was feasible, and to ascertain the potential economies that might be effected through the consolidation, three shops in Denver were operated according to the new plan under one management; and this procedure also allowed more time for selecting a site and for the designing of the proposed composite plant. By the early part of 1924, there was thus obtained ample information on which to base the design of the new shops. The needful financial arrangements were made, and building was started in May, 1924. The plant is now operating.

The shops are situated in Arapahoe County just across the south line of the City of Denver, and alongside the tracks of the Santa Fe, the Colorado & Southern, and the Denver & Rio Grande Railroad. The buildings are of concrete, brick, and steel, with walls composed largely of Fenestra sash. The plant reservation has an area of seventeen acres; and it is located in a district where high-class labor can be readily obtained. Before construction was begun, engineers were sent to many important plants in the East for the purpose of securing the latest data on methods of handling raw and finished materials, on the arrangement of tools, the disposition of buildings, etc.

The buildings and the tools have cost approximately $1,000,000; and there is reason to believe that the establishment is the equal if not the superior of any jobbing shop west of Chicago.



**Airplane photograph of the plant of the General Iron Works located just outside the city limits of Denver, Col.**

**Denver is a city of many points of interest. Top—U. S. Post Office Building. One of the big mountain-climbing locomotives of the Moffat Line. Bottom—State Capitol dominates Denver. One of the entrances to the beautiful Civic Center.**

The General Iron Works has no estimating or sales organization. It takes orders from none but its own stockholders, who are its only customers. These stockholders, in addition to The Stearns-Roger Manufacturing Company, include The Dorr Company, The Colorado Iron Works, The Vulcan Iron Works, and The Mine & Smelter Supply Company. These associate companies retain their present offices, their selling organizations, and their engineering departments, but they have closed the plants which they previously operated as independent enterprises.

Recently, the Stearns-Roger Manufacturing Company acquired the good will, patterns and drawings of The Denver Engineering Works, The Plains Iron Works, and The Davis Iron Works—thus further increasing the volume of work tributary to the new shops.

The consolidation scheme of the General Iron Works—though novel, is economically sound. The main efforts of all the contributing companies can now be devoted more than ever to engineering and distributing over a territory greatly increased in area by reason of the lower manufacturing costs of their products and the greater capacity and better manufacturing facilities now obtainable.

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The year 1924 witnessed America's greatest export movement—in point of tonnage—in dried fruit in the history of the trade. A total of 200,000 tons, valued at $30,000,000, were shipped abroad.

## ALLOY-STEEL RIVET SET INSURES LONG LIFE

A NEW rivet set for pneumatic hammers has been turned out by the Ingersoll-Rand Company, of New York. This set, known as the "Jackset," is made of high-grade alloy steel which is specially forged and then heat treated by a new process. The steel can therefore be subjected to greater heat from hot rivets than is ordinarily the case without the temper becoming drawn.


**"Jackset" which is made of alloy steel.**

Years of experience in manufacturing rivet sets, and hundreds of tests with different kinds of steel and various methods of heat treatment have produced a rivet set of exceptional durability. In short, it is claimed for the "Jackset" that it is better able to withstand the stresses of riveting than carbon-steel sets—in other words, that it will outlast three, four, and even more carbon-steel sets. This gain in strength not only means less breakage and less lost time, but it also increases the number of rivets that can be driven per set.

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## ALUMINATE CEMENT NOW MADE IN AMERICA

WHILE aluminate cement has been used extensively in France for more than a decade still this valuable fast-setting structural material is only now being manufactured in America. The cost of this admirable product is somewhat higher than ordinary grades of cement owing to the amount of alunite employed in its making. But this added cost is more than offset by the very desirable properties of aluminate cement, which sets quickly and becomes as strong in the course of 24 hours as other cements do only after the expiration of 28 days.

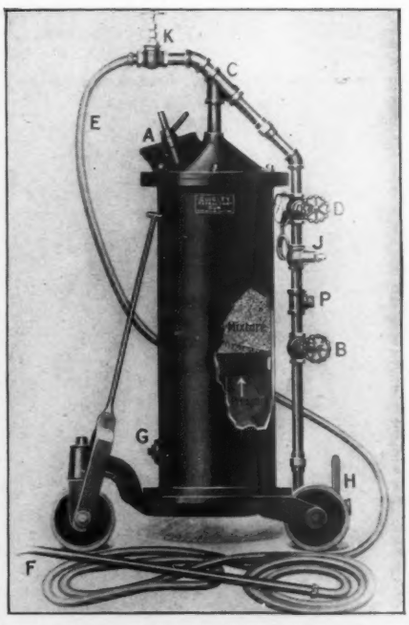

**The Witwatersrand Show of 1925, held in Johannesburg, South Africa, drew to it a total of approximately 90,000 visitors during the week of its existence. As might be expected, it was the occasion for the display of many kinds of mining equipment; and the exhibit of the Ingersoll-Rand Company was notable because of the diversity of its products, which have played an important part for years in the activities of the Witwatersrand.**

## NEW AIR GUN DEVISED FOR REPAIRING FURNACES

A NEW refractory gun has been put on the market by the Quigley Furnace Specialties Company that is said to reline, patch, and surface furnace walls rapidly and at low cost. It is also claimed by the manufacturer that parts of furnace walls or baffles hard to reach by hand can be quickly repaired or hot patched by means of this gun, which is operated by compressed air.

Premixed refractory materials of proper consistency are placed in the gun, and the operator, by manipulating suitable valve controls, forces the mixture first through a section of hose and thence outward through a suitable nozzle. The pressure required to apply the mixture varies from 90 to 100 pounds, depending on the nature of the material used. For heavy, plastic mixtures, a pressure of from 95 to 100 pounds is necessary, while work calling for thin mixtures has been done at as low a pressure as 50 pounds.

As the illustration shows, the gun consists of a cast-iron cylinder from which the material is forced by pressure applied to a piston. The material is placed in the gun through a charging opening, A, in the top. Pressure is applied at the bottom of the piston through pipe connection, P, and is controlled by valve, B. As the piston rises, the mixture is forced into the Y-connection, C, from which point the refractory material is forced through the hose to the nozzle by the movement of the piston and the pressure applied through the air-control valve, D. A drain plug, G, is located just above the piston, and a quick-opening cock for releasing the pressure is placed under the piston, at H. When the gun is empty the cock H is open, and the piston returns to its starting position. The gun is then ready for refilling. A pressure gage and a pop-safety valve are at J.




**Quigley refractory gun: A—Filling door; B—Piston pressure valve; C—Delivery line connection; D—Air control valve; E—Hose; F—Nozzle; G—Clean out plug; H—Pressure-relief cup; J—Safety valve and gage; K—Back pressure valve; and P—Pressure line connection.**

The gun has a capacity of two cubic feet of material. It is mounted on three wheels, and can be easily moved from place to place. When not required for furnace repair work the Quigley gun can be used about a plant for rough whitewashing, for spraying paint or for placing plastic mixtures, such as stucco and the like.

## COMPRESSED AIR IN THE PAPER MILL

COMPRESSED air, as we all know, is handy for all sorts of odd jobs; and when a supply of it is maintained for special use it generally finds employment for other purposes. In paper mills, the wood chips are stored in large bins. In feeding the chips into the digesters the mass is frequently choked, and nothing frees it so effectually as a blast of compressed air. For this purpose, a pipe is connected to the main air supply by a length of flexible hose. This pipe is worked up into the mass of chips to be loosened; and when the air is turned on the material is quickly released and flows on again as required.

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In connection with the better-roads program, the Government of Peru has adopted legislation whereby an additional tax of one-half centavo has been placed on each cigarette sold in the country. The proceeds, estimated at $2,000,000 per annum, will be spent in building roads.

# Two Experts Discuss Liquid-Oxygen Explosives

**IN the July issue, 1924, we printed a leading article, entitled "Liquid-Oxygen Explosives in Epoch-Making Blast," which was written by Mr. F. W. O'Neil. Subsequently, that article was reproduced in The S. A. Mining & Engineering Journal, and attracted widespread attention.**

**Later on, Mr. O'Neil's paper was criticized in the same South African journal by Mr. C. M. Parkes, Managing Director of Liquid Oxygen Explosives, Ltd., of London. For the information of our readers, we are now reprinting Mr. Parkes' communication and have given Mr. O'Neil an opportunity to make a rejoinder.**

TO the Editor, *S. A. Mining and Engineering Journal.*

Dear Sir:—

"I was extremely interested to read extracts from Mr. O'Neil's report in the 6th September, 1924, issue of your journal on *Liquid-Oxygen Explosives,* which were used for the tests carried out in the quarries at Myerstown, and as certain statements and conclusions arrived at by Mr. O'Neil are not altogether accurate, and as they refer to European practice in which I am personally interested, I hope you will spare me the necessary valuable space in order to correct some of his statements.

"Although there are many points that are open to discussion, space does not allow taking all the points which are raised; but Mr. O'Neil makes three specific statements which I give below and which I propose to deal with.

1. The test at Myerstown was the first of its kind on a commercial scale ever made in the United States and probably the largest blast ever made anywhere with L.O.X.

2. The cost of L.O.X. amounts to 42⅔ per cent. the cost of dynamite, and by making certain assumptions regarding overshooting, the cost can be reduced to 34 per cent. of the cost of dynamite.

3. The soaking vessels used in Europe are not large enough to contain more than a single cartridge of the size used at these Myerstown trials.

"In regard to these statements, I should like to take this opportunity of drawing your attention to some trials carried out at Sorcy, France, in August, 1923, or some nine months prior to the Myerstown trial in which:

1. A larger blast than that at Myerstown was made and more than double the weight of rock broken down.

2. Much greater reduction in cost was shown.

3. Vessels such as are stated in the Myerstown report to be unavailable were actually used.

"It is first of all necessary to reduce the results of the Myerstown tests to a standard basis which can be used for comparative purposes, and this I propose to do by stating them in terms of:

1. The cost per ton broken down.

2. Weight of explosive per ton broken down.

3. Weight broken down per foot of hole drilled.

"The following information on the Myerstown experiments, 11th April, 1924, has been taken from Mr. O'Neil's article in the *Compressed Air Magazine* for July, 1924:

Number of holes, 12; depth of holes, 30 feet; diameter of holes, 5½ inches; number of cartridges, 60; weight of cartridges unsoaked, 195 pounds; total weight of liquid oxygen used, 906 pounds; estimated liquid-oxygen explosive present at $CO_2$ point, 721 pounds; weight of rock broken down, 4,500 tons; estimated cost of L.O.X. 8 cents per pound.

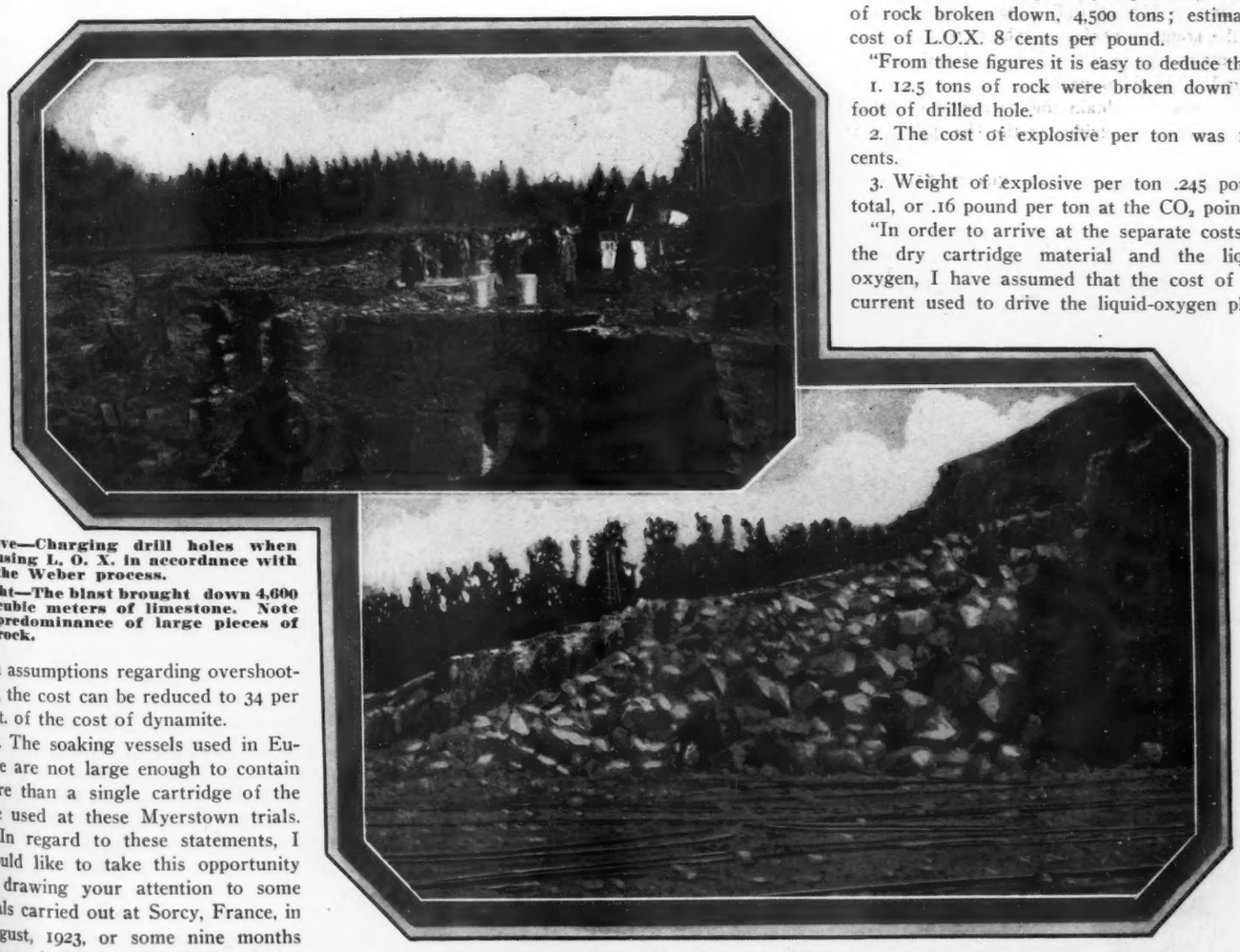
"From these figures it is easy to deduce that:

1. 12.5 tons of rock were broken down per foot of drilled hole.

2. The cost of explosive per ton was 1.28 cents.

3. Weight of explosive per ton .245 pound total, or .16 pound per ton at the $CO_2$ point.

"In order to arrive at the separate costs of the dry cartridge material and the liquid oxygen, I have assumed that the cost of the current used to drive the liquid-oxygen plant



**Above—Charging drill holes when using L. O. X. in accordance with the Weber process.**

**Right—The blast brought down 4,600 cubic meters of limestone. Note predominance of large pieces of rock.**

**About 4,950 tons of rock broken down by the Weber process in a limestone quarry.**

is .6 to .7 cents per kilowatt-hour, and this makes the cost of the liquid oxygen 2.5 cents per pound. This figure allows for delivery to the quarries and losses in transit, etc. According to Mr. O'Neil's figures, the cartridge at the point of perfect combustion—$CO_2$ point—contains .27 pound of dry material and .73 pound of liquid oxygen.

"In order to obtain the .73 pound of liquid oxygen in the cartridge at the $CO_2$ point, it is necessary to provide at the quarry $.73 \times \frac{906}{525} = 1.26$ pounds of liquid oxygen. It is therefore possible, by subtracting the cost of 1.26 pounds of liquid oxygen at 2.5 cents per pound—that is, 3.15 cents from the total cost per pound equaling 8 cents, to obtain the cost of the .27 pound of cartridge material. This gives 4.86 cents, which makes the value of the dry cartridge material, wrapper, etc., 18 cents per pound.

"I now give the results obtained at Sorcy on August 6th, 1923. These tests were carried out in the presence of Mr. George Rice, Chief Engineer of Bureau of Mines, Washington, D. C., and his secretary, Mr. Lawrence Lichfield; and by Mr. Weber, the inventor of the Weber cartridge and processes. The rights to these processes belong to Messrs. Les Petits Fils de Francois de Wendel & Co., 3, Rue Paul Baudry, Paris; and my company, Messrs. Liquid Oxygen Explosives, Ltd., is their sole concessionaire for England and British Possessions.

"The following are the particulars of the trials:

Number of holes, 10; depth of holes, 3 feet; diameter of holes, 6 inches; number of cartridges, 120; weight of unsoaked cartridge, 684 pounds; weight of liquid oxygen, 1,7 pounds; weight of rock broken down, 10,1 tons.

"From the above figures may be deduced:

1. Weight of rock broken down per foot of hole, 26 tons.

2. Weight of explosive per ton broken, .2 pound.

3. Cost per ton broken down, .973 cents.

"The last figure is arrived at by adding together .067 pound of Weber absorbent material at 8 cents per pound, and .175 pound of liquid oxygen at 2.5 cents per pound. The same price used for liquid oxygen as in the Myerstown tests; and the cost of the Weber absorbent includes all charges for special charging, etc.

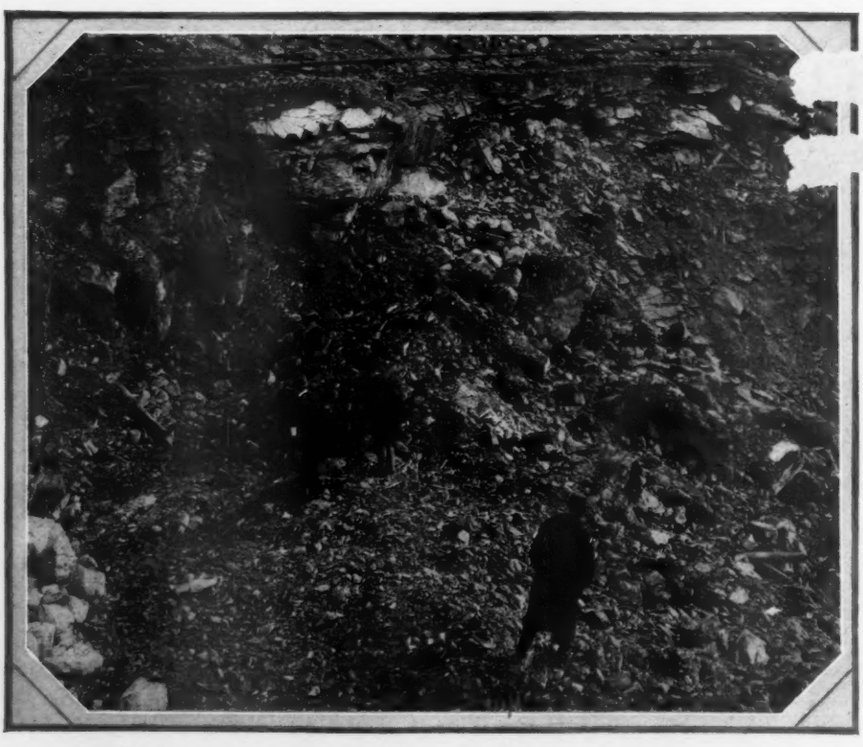
"We therefore get the following comparison of the two tests:

| | Weber Process | Myerstown Test |
|---|---|---|
| Total tonnage ..... | 10,140 tons | 4,500 tons |
| Cost per ton broken down ..... | .97 cents | 1.28 cents |
| Rock broken down per foot of hole drilled | 26 tons | 12.5 tons |
| Weight of explosive per ton of rock .... | .243 lbs. | .245 lbs. |

"It will be seen that with the Weber process a saving of 32 per cent. over the Myerstown figures can be effected in the cost per ton broken down; also, the rock broken down per foot of hole drilled was more than twice the amount. It was thought after the blast at Sorcy was finished that the same effect might have been obtained with three less holes, which would have meant an explosive expenditure of only .73 cents per ton—this would show a saving of 40 per cent. over the Myerstown figures after allowing for the overshooting suggested by Mr. O'Neil, or 77 per cent. on the results as given.

"With regard to the soaking vessels used at the Sorcy test, these were of the Weber double vacuum type and held 7 to 10 cartridges. The vessels were 26 inches high and 18 inches in diameter and were carried full by two men to the holes to be charged. This arrangement, besides being much more handy than the large vat used at Myerstown, avoids the losses by surface evaporation and allows the cartridges to be carried to the hole before being taken from the soaking vessel, which would be impossible with a vat such as was used at Myerstown.

"It may be of interest to your readers to know that better results than those given above have since been obtained during other tests at



**After the liquid-oxygen blast at Myerstown, showing the general absence of large pieces of rock requiring popholing.**

the Ranguevaux Quarries, Moselle, on the 18th April, 1924, when the following results were obtained: Number of holes, 5; depth of holes, 26 feet; diameter of holes, 6 inches; rock broken down, 4,950 tons. These figures show a yield of 38 tons per foot of hole drilled.

"In this instance, ordinary methods of charging were used; but by using a special patented process for charging the holes, and even with a delay of one hour between commencing to charge and firing the shots, it has been possible to obtain 20 to 23 tons per foot of 4-inch hole drilled. This figure was obtained with 4-inch-diameter holes, 26 feet deep, and corresponds to an explosive cost of only .7 cents per ton.

"In conclusion, it is only fair to assume that the Weber process, owing to its being in use since 1914, would show savings in cost and greater output when compared with new types of liquid-oxygen explosives.

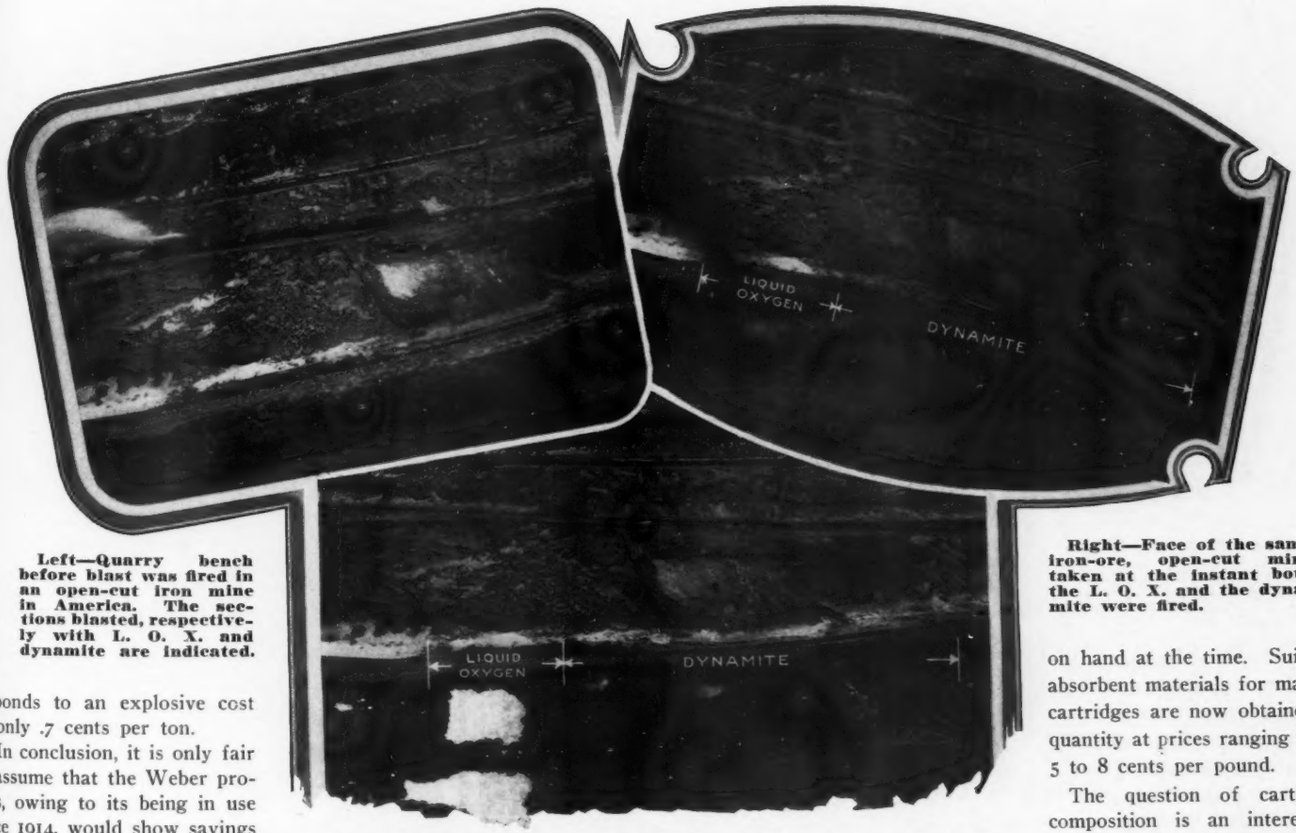
"At the present time, 8,000,000 tons of ore* per annum are broken down with the Weber cartridge in the Lorraine mines, and this is the best guarantee that one could give to anyone who had to decide on the advisability of incurring the cost of a liquid-oxygen installation to displace the use of high-price explosives from his mines.

"I enclose two photographs showing the Sorcy trials and three photographs of the Ranguevaux trials, showing the ground before and after the explosions and method of filling the holes.

Liquid Oxygen Explosives Limited,
C. M. Parkes,
Managing Director."

January 22, 1925.

*Metric tons of iron ore.*




**Left—Quarry bench before blast was fired in an open-cut iron mine in America. The sections blasted, respectively with L. O. X. and dynamite are indicated.**

**Right—Face of the same iron-ore, open-cut mine taken at the instant both the L. O. X. and the dynamite were fired.**

**Bottom—Quarry face as it appeared immediately after firing. Note the general similarity of the broken condition of the ore blasted by L. O. X. and by dynamite.**

May 25, 1925.

To the Editor, *Compressed Air Magazine,*

Dear Sir:—

Mr. Parkes' letter is extremely interesting, showing as it does the parallel development of the use of L.O.X. in large churn-drill holes in Europe and in America and indicating the difference in quarrying conditions in the two countries. The three specific statements in my article to which Mr. Parkes takes exception may be commented on briefly as follows:

1. "The test at Myerstown was the first of its kind on a commercial scale ever made in the United States, and probably the largest blast ever made anywhere with L.O.X." The statement that this was the first blast of its kind on a commercial scale in the United States still stands. The honor of having fired a larger shot in Europe is freely conceded to Mr. Weber, and we regret that we did not know of it earlier. In this connection it may be of interest to state that blasts of 40 holes, similar to those at Myerstown, are now being fired regularly with L.O.X. in this country; and there is no reason why twice this number should not be fired simultaneously where it is necessary to do so.

2. "The cost of L.O.X. amounts to 42⅔ per cent. of the cost of dynamite, and, by making certain assumptions regarding overshooting, the cost can be reduced to 34 per cent. of the cost of dynamite."

As applied to this particular blast these figures still stand, and Mr. Parkes' ingenious deductions from them are in the main correct. Mr. Parkes estimates that oxygen costs 2.5 cents a pound—with power at .6 or .7 cent a kw-h. This may be true of less efficient plants which do not use the Claude process. With current at the cost given, the Claude process will turn out oxygen at 2 cents or less a pound.

The cartridges used in the Myerstown blast cost more than 18 cents per pound of dry weight. This material had been purchased for experimental purposes and was used as it was on hand at the time. Suitable absorbent materials for making cartridges are now obtained in quantity at prices ranging from 5 to 8 cents per pound.

The question of cartridge composition is an interesting one. Tests covering over 1,000 various cartridge materials and mixtures have been made by us both in the laboratory of the United States Bureau of Mines, at Pittsburgh, Pa., and in actual blasting. These tests included a study of most of the commercial cartridges available in Europe—sample lots having been obtained from France, Germany, and Italy; and it is our opinion that a properly made cartridge of a suitable lamp black or carbon black is better than anything else that can be obtained.

3. "The soaking vessels used in Europe are not large enough to contain more than a single cartridge of the size used at this Myerstown trial."

This statement was based on the fact that the largest soaking vessels we had been able to obtain were made specially for us in France and were slightly under ten inches in diameter by eighteen inches deep. I gladly accept Mr.

Parkes' correction that larger vessels are being made.

Our experience with vacuum-insulated soaking vessels has not been satisfactory. They are expensive, both in first cost and maintenance, and do not stand the rough handling which they invariably receive. We have made an extensive study of the loss of oxygen occurring during soaking and find that, for vessels of equal size, the quantity of liquid saved by using a vacuum soaker as against a plain copper-lined, sheet-iron can with an inch or two of hair felt or mineral wool insulation is negligible. Where one large box of the type employed at Myerstown is used to replace a large number of small vacuum soakers there is a great economy of oxygen in favor of the larger box due chiefly to the much smaller surface of metal to be cooled down.

Mr. Parkes to the contrary, the chief reasons for the use of large soaking boxes are: their greater convenience and the saving of labor involved. Consider, for example, a typical shot of 30 holes with six 5 x 18-inch cartridges per hole. These cartridges would all be soaked at one time in three boxes of the Myerstown type. With suitable racks over the boxes to hold the inverted oxygen containers the entire soaking can be completed by two men in from 30 to 40 minutes. The cartridges are then withdrawn from the boxes and thrown in a cart or hand car and taken to the quarry bench. As the cart proceeds, the proper number of cartridges is dropped into each hole and the stemming shoveled in by a couple of men who follow up behind. Half a dozen men are sufficient for the average shot, and the loading is completed practically by the time the cart reaches the end of the line of holes.

**Soaking tank, some of the big cartridges, and a few of the transportation bottles in which the liquid oxygen was delivered at Myerstown.**

Our experience with small soakers has been that so many men are required and that the bench is cluttered up with so much equipment that they become an intolerable nuisance and entirely impractical for everyday use. One of Mr. Parkes' pictures shows this condition clearly at Ranguevaux, where only five holes are being loaded.

Mr. Parkes' comparisons between the Myerstown blast and those at Sorcy and at Ranguevaux are extremely misleading, as they neglect entirely the most important point in all blasting, that is, the nature of the material being broken. There are limestones, for instance, in which three tons per pound of explosive would be considered satisfactory and others in which four to five tons per pound would not be particularly good.

The tonnage obtained per foot of hole is influenced fully as much by the character of the rock as it is by the powder used. At Ranguevaux the figures are: depth of holes, 26 feet; diameter, 6 inches; tons per foot of hole, 38. This stone in place probably runs about 10 cubic feet to the ton. A yield of 380 cubic feet of stone per foot of hole indicates holes spaced on from 19- to 20-foot centers. We have not been fortunate enough to encounter in our work with L.O.X. in this country any limestone which can be broken satisfactorily by any explosive in 26-foot by 6-inch holes spaced 19 to 20 feet apart.

It would be interesting to have the figures on the quantities of explosive ordinarily used at Sorcy and at Ranguevaux in similar holes before the advent of L.O.X. so as to get at the actual reduction in cost of explosives under the same conditions. I understood, for example, that in Lorraine, where the Weber cartridge is being used so extensively, the explosive replaced was not dynamite at all but black powder.

Another point which has been overlooked by Mr. Parkes is that of secondary blasting, that is, once the rock has been thrown down how much additional blasting is required to reduce it to a size which can be handled by the shovels and crushers. In this connection the photographs taken after shooting at Sorcy, Ranguevaux, as compared to Myerstown speak for themselves.

An interesting direct comparison between L.O.X. and dynamite is furnished by some of the accompanying pictures. The holes are 42 feet deep and in iron ore. The shot consisted of 80 holes—16 at the left-hand end being loaded with L.O.X. and the balance with a mixture of 40 per cent. and 60 per cent. gelatin. The entire shot was fired simultaneously with cordeau. In this instance, the results indicate a saving of about 50 per cent. in cost by the use of L.O.X.

F. W. O'Neil,
Chief Engineer, Ingersoll-Rand Company

## BIRMINGHAM-TO-MERSEY CANAL PROJECT

THE construction of a canal from Birmingham, England, through Wolverhampton and Stoke-on-Trent to the Mersey, capable of transporting 100-ton barges, has recently been proposed. This route is claimed to be more suitable and practical than the southern route to the Severn, which has been under consideration for some time.

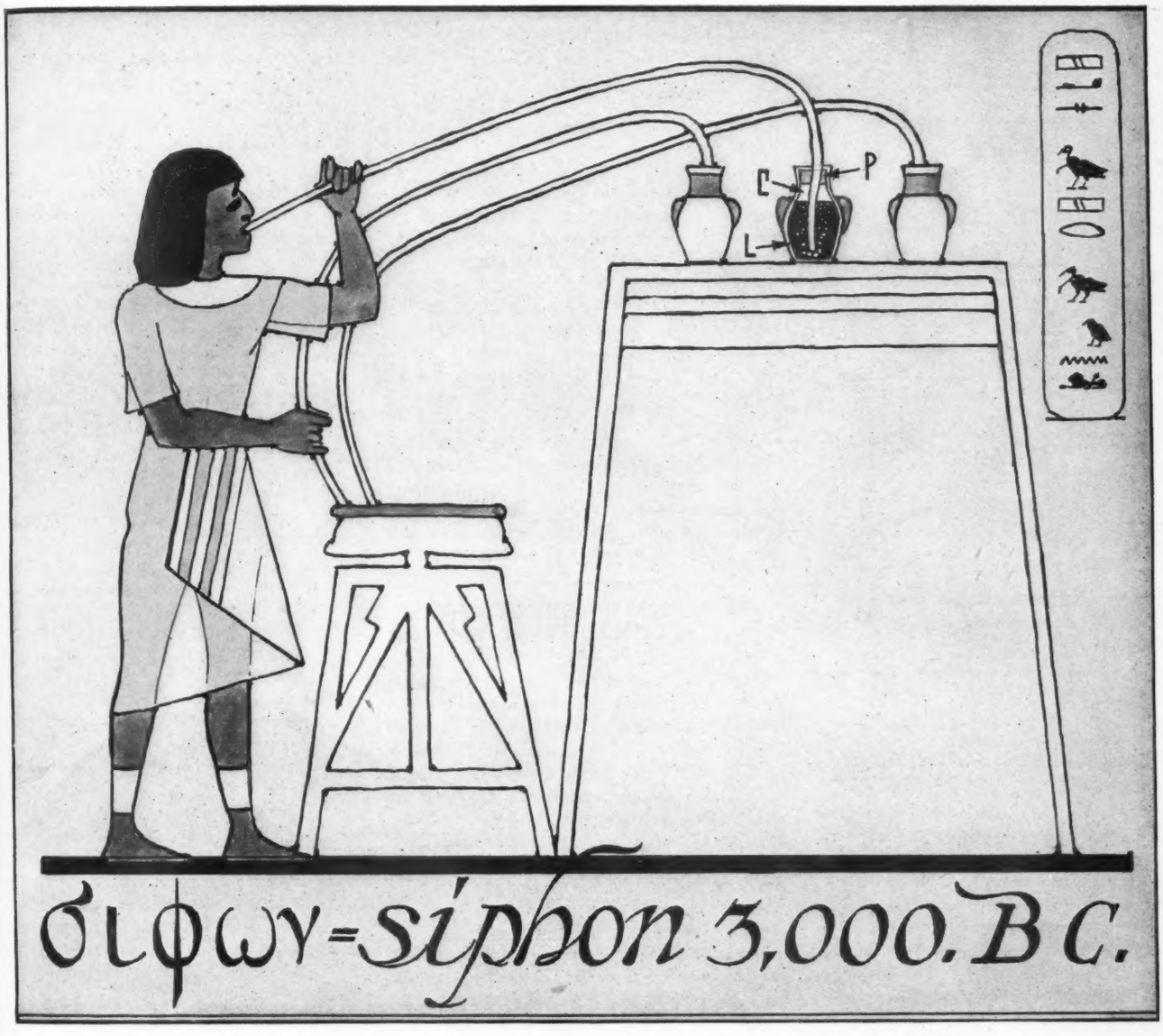
The present plan calls for the unification, enlargement, and straightening of several existing canals that follow devious courses; that are capable of accommodating only small craft; and that are under different administrations. The estimated cost of the project is $32,000,000.

The City of Duluth, Minn., lies directly opposite Superior, Wis.—being separated by a ship channel which forms the entrance to the busy harbor of Duluth. There is a highway bridge, connecting the two cities, on which the traffic averages 3,000 vehicles daily. This traffic is subjected to frequent stoppages and long delays, as the heavy shipping on the waterway keeps the drawbridge open anywhere from two to seven hours a day.

A tunnel is obviously needed to relieve the situation; and it is seriously proposed by the commissioner of public works of Duluth to build such a structure at an estimated cost of about $4,000,000. No novel or special engineering problems seem to be involved in the undertaking.

Just as Chicago has become the focal point of land transportation in the United States because of its location, so is that city evidently destined to become the center of the air business of the continent. One can now fly, at a cost of $50, from Chicago to New Orleans—or the other way about—with stops at St. Louis and Memphis. Mail has been carried over the same route since April. Plans are underway to connect Minneapolis, Chicago, New York, and Boston by express and passenger airplanes.

# Compressed Air Used To Raise Fluids Five Thousand Years Ago




Drawn by Charles Beecher Bunnell.

THE siphon of today is merely a variation of the siphon of Hero's day; and the siphon of Hero's day was a reproduction of a device pictured upon the palace walls of one of the Egyptian rulers 3,000 years B. C.

Hero, so we are told by prominent historical authorities, probably lived during the second half of the first century of the Christian era. That Greek writer on mechanical and physical subjects left behind him records dealing with human knowledge of his time and of accomplishments in his chosen field dating thousands of years earlier.

The accompanying drawing, by Charles Beecher Bunnell, illustrates the working of what is commonly known in books on physics as Hero's Fountain. Hero described this use of compressed air in some detail in his work, still extant, entitled, PNEUMATIKA, which he devoted to exploiting the uses of air pressure and siphons.

Once more we have graphic evidence that there is very little that is new under the sun. The Greek slave is blowing into a sealed vessel by means of a hollow reed which enters that vessel through the stopper P, and discharges well below the surface of the liquid, L. Thus, a volume of compressed air is confined within the space, C, above the liquid, and when the pressure is raised sufficiently and allowed to react upon the liquid it is capable of forcing nearly all of the confined fluid up and out through the reed and into the basin on the table in front of the slave.

The principles of the ancient siphon are applied daily in manifold ways to reinforce the actions of pumps and to lift water and other fluids to greater heights than would be possible if atmospheric pressure alone were counted upon to raise water in response to the patrial vacuum caused by the movement of the piston of a suction pump.

What the Egyptians may have done and whatever Hero showed could be done by utilizing the principles of the siphon—probably somewhat spectacular in the light of those distant days—was at best but a comparatively puny utilization of natural forces when contrasted with what is now achieved by the modern engineer employing the self-same principles of physics.

The great difference between the performances of the past and those of this age of ours may properly be termed the milestones which mark how much farther onward we have forged in putting engineering knowledge to widespread and to useful account for the good of many millions instead of for the questionable benefit of a favored few—such as was undoubtedly the case when the ancient Egyptians conceived the siphon. Surely the world has gone forward a long way in material achievements since Hero explained how compressed air could be made to lift water up hill.

# Compressed Air Magazine

—*Founded* 1896—

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*EDITORIALS*

## DISTRIBUTION OF WORLD POPULATION

JUST once so often, statisticians and other students of human problems go to some trouble to point out the dire prospect of the world becoming too crowded with multiplying human beings to provide for their support from the natural resources of the globe.

Whether or not this will ever come to pass is, of course, debatable, but it is self evident to the geographic expert that some parts of the world are overcrowded while other parts are but thinly settled or occupied. There are both natural and economic reasons for these differences—some of them being climatic, while others are the direct outcome of intensified industry.

In a recent issue of Commerce Reports, H. M. STRONG has pointed out some interesting facts regarding the distribution of the world's population. As he expresses it, "Large, or at least considerable, numbers of people are living on most of the lands throughout the world which are favorable for human habitation, the principal exceptions to this being southern Siberia, southern Brazil, Argentina, southeastern Australia, and South Africa. With these exceptions, the present sparsely peopled areas are hot or cold deserts which cannot support large populations.

Three island areas, England, Japan, and Java, stand out because of their dense populations. In England, the crowding of peoples is due to industrial developments. In Japan, it has been chiefly the result of intensive agriculture carried almost to the limit of production as related to subsistence, and only recently have the elements of manufacturing entered to further increase the density. Java represents entirely different conditions. It is a tropical island, within a few degrees of the equator, containing a large area of level, highly fertile, and well-watered land. The Dutch have maintained stable political conditions in Java for many years, thus favoring the development of a highly productive tropical agriculture. Java and Cuba, each a tropical island, are strongly contrasted. Both are approximately the same size, yet Cuba has about 3,000,000 people as compared with 34,000,000 in Java."

What is manifest in well-nigh every instance of dense population is that a great mass of people is focused within a relatively limited area through the urge of one or another form of intense industrial life. Therefore, to relieve the stress of such a situation it will become imperative for future generations to seek elbow room in those thinly settled regions where natural resources offer the means of livelihood and an environment in which life may be enjoyed. It is self evident that there still remains space for a vast expansion of the human race before the earth becomes occupied to an intolerable degree.

## RAIL PASSENGER SERVICE A CENTURY OLD

ONE hundred years ago, on September 27th, 1825, the first passenger-carrying steam railway train made its memorable run between Stockton and Darlington, in England. The locomotive used then was able to draw a load of approximately 90 tons at the rate of twelve miles an hour; and, revolutionary as that service was, fraught with well-nigh incalculable social and economic potentialities, there were thousands of persons that protested loudly and long against the innovation which threatened the horse-drawn stagecoach as a common carrier.

We of today can little understand the opposition manifested by the English public one hundred years ago. To us, railway transportation is a recognized essential in our daily life, not only as a means of getting us rapidly from point to point over long distances, but as the medium by which our postal matter in tremendous quantities is carried to and fro at high speed from one end of the country to the other. One and all of us are ready to acknowledge our indebtedness to the steam locomotive as a means to the comfort, convenience, and the very maintenance of the standards of life upon which we now insist.

Decade by decade in the beginning, and latterly almost year by year, the locomotive designer and builder have evolved engines of increasing power and greater capabilities so that these "iron horses" might be able to meet successfully the continually growing demands made upon our far-flung trunk-line railways. Compared with the locomotive of 1825, the locomotive of 1925 seems, and is in fact, a veritable titan. Even so, the largest of our present-day steam locomotives are frequently hard put to it, overtaxed, to draw the loads and to mount the grades at the speeds now desired in covering considerable distances. Engineering cunning has done well-nigh its utmost to put in a single steam locomotive sufficient power to satisfy insistent requirements. Therefore, the engineer has cast about for some other agency wherewith to develop most efficiently the needful power at a minimum expenditure of fuel.

As a consequence, we have something new in self-contained tractors—that is, the oil-electric locomotive which combines the notable operative economies of the heavy-oil engine with the admirable characteristics of the electric locomotive. This newcomer in the realm of railroading has, unquestionably, before it an immense field of service; and perhaps its adoption may mark the beginning of an era in railroading quite as revolutionary as that marked by STEPHENSON'S locomotive when first applied to the hauling of passengers in 1825.

## PROTECTIVE COLORING FOR OIL TANKS

"ANY color so it's red" is a well-known saying among some people, but this chromatic liberality does not apply when it comes to the painting of tank farm containers. Indeed, scientists tell us that there is very much of a preference in this matter, strange as it may seem to the casual observer.

Evaporative losses have been notably high and incidently costly for years in cases where petroleum products have been held for storage in tanks exposed directly to sunlight; and considerable experimenting has been carried on to ascertain how far coloring affected the rate of evaporation. The U. S. Bureau of Mines has recently concluded some very suggestive experiments in this field of inquiry; and the containers were coated, respectively, with black, red, gray, and aluminum paints. The tanks were filled with crude oil containing approximately 29 per cent. of the lighter volatiles, such as gasoline and naptha; and the tanks were sealed as far as practicable to render them vapor-tight during their open-air exposure throughout a period of twelve months.

At the conclusion of the test period, the tanks coated with gray and aluminum paints gave notably superior results—the aluminum-painted tank showing considerably less evaporation than the gray-painted tank. In short, the evaporation was reduced in accordance with the coating's capacity to reflect radiated heat waves. The findings should be of value in determining how best to paint other structures so as to insure lower interior temperatures.

## ANOTHER GREAT TASK FOR THE ROCK DRILL

THE engineering authorities of Greater New York plan to amplify the existing water supply system of the municipality by constructing a tunnel which will cost substantially $64,000,000.

This new tunnel will deliver Catskill water to the Boroughs of Brooklyn and Queens. It will have a diameter of 17 feet, and will be driven through solid rock at a depth of 500 feet below the surface of the ground.

The need for this tunnel was made clear by the Municipal Water Department some years ago when its engineers pointed out that within fourteen years the city would be consuming all its available supply of safe water. The tunnel would require nearly seven years to build; and, when completed, this giant rock hewn artery will provide not only for the increased population but it will add measurably to the city's protection against fire.

## AMERICAN WORLD TRADE

*By W. L. SAUNDERS*

OFFICIAL figures are now available showing the world trade of the United States for 1924. We exported over $4,500,000,000, an increase of 10 per cent. over the year 1923. We imported over $3,500,000,000, a decline of nearly 5 per cent. from 1923.

Our largest exports were, first, raw cotton, 21 per cent.; wheat, next, 5¼ per cent.; third, automobiles and parts, over 4½ per cent.; then came gasoline and other light-oil products, tobacco, copper, lard, and coal and coke. Agricultural machinery exports made a new high record, being fourteenth in line, with a gain of 19 per cent. over the previous year. Exports of corn fell off 51 per cent. Gasoline and other light-oil products increased 24 per cent. Machinery exports increased 10 per cent.

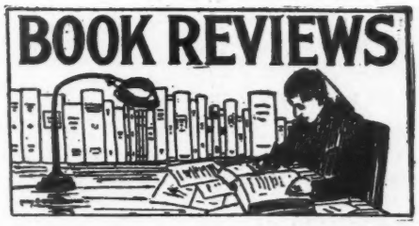
Selecting 100 of our chief imports, representing 87 per cent. of the total value of all United States imports, it is interesting to note that 23 out of the 100 were imports of crude materials for use in our domestic manufacturing industries. A large increase occurred in imports of crude petroleum—the gain being 27 per cent. over 1924. Topped petroleum, including fuel oils, increased 66 per cent.

## LESSENING THE HAZARD OF HUMP RIDING

SWITCHES operated jointly by electricity and compressed air, and controlled by a switching machine placed in a conveniently located central tower, bid fair to greatly reduce the hazards ordinarily associated with the classifying of cars in a busy railroad freight-yard.

According to a recent news account, "hump riding," that is, riding freight cars down an incline while classifying them, has long appealed to many railroad men because of the danger involved, and the skill required in handling the cars and in avoiding collisions the while. Gravity is the compelling force, and the task of the riders is to apply the brakes at the right moment so as to slow up the movement of the speeding car and to join it with the growing train without undue violence of impact. Indecision or lack of judgment might easily cause loss of life and serious damage to property.

This practice has prevailed generally for years, and the consequences have been extremely costly and the injuries and loss of life high among the men doing this work. Recently, one of the big railroad lines of the Middle West has been testing at two of its terminals a car retarder system which has functioned admirably, and which has shown that it is possible in this way to effect very substantial economies and greatly to reduce the risks to life and limb. Furthermore, the electro-pneumatically operated retarder system enables the railroad to handle effectively and speedily the peak load demands and to do this under weather conditions that commonly crippled the service when the retarding is manually performed by the car riders. There is warrant for the belief that this new use of compressed air and electricity will be widely adopted by railroads.




A. PITMAN'S NOTE BOOK, by Roger Dataller. A book of 271 pages, published by Lincoln MacVeagh, The Dial Press, New York City. Price $2.50.

THIS book is a unique and absorbing revelation of a human type of which the general public knows but very little, although substantially all of us are either directly or indirectly the beneficiaries of his labors. The author of the note book is "a human mole, the son of generations of miners." It is not a scientific treatise on the art of coal mining, but is a sincere, sympathetic, and at times a humorous picture of colliery conditions and of the work done by these essential toilers far below ground. The book has been described as a genuine literary discovery, and whether this be true or not, the fact remains that the pages of the diary are filled with many absorbing details and picturesque sidelights upon an industry which is not primarily a picturesque one.

IS IT GOOD ENGLISH? by John O'London. A volume of 189 pages, published by G. P. Putnam's Sons, New York City, Price $2.00.

PRECISION in the use of our mother tongue may be acquired only by a deal of conscientious study—no matter what may be the native gift of the individual in the matter of facility of speech. No one can expect to acquire a commendable command of English merely by buying anyone of a large number of works on the subject. Conscientious reading of one or more of these books will help tremendously, but the treatment of the subject, by the majority of the authors, is such as to halt the run of English students. The present volume is a refreshing exception to the rule, and the treatment is so delightful that one goes reading on without realizing the while that he is receiving instruction and dealing with a lesson or lessons on every page. The volume is not intended to be profound, but is designed to help us to think and to express ourselves clearly and to avoid the more conspicuous faults of our common speech.

NON-TECHNICAL CHATS ON IRON AND STEEL, by LaVerne W. Spring. An illustrated work of 358 pages, published by the Frederick A. Stokes Company, New York City. Price $3.00.

IN this age of well-nigh unlimited applications of ferrous metals it should be a matter of wide-spread interest to know how iron and steel are produced for these multiple purposes. The author has produced a highly instructive and, withal, a very interesting presentation of this important subject. He has employed a simple, narrative style, free from technicalities, and yet has succeeded admirably in giving the facts and in imparting the spirit of the modern great steel mill.

As might be expected, the treatment starts with the early history of iron, deals with the sources of the raw material, and carries the reader from the mine to the finished products. Incidentally, some of the "mysteries" of the metallurgy of alloy steels are disclosed, which help to explain how steels of different sorts can be made to meet many different needs and services.

*Report of Board of Visitors to U. S. Bureau of Standards.* This is No. 63 of the Bureau's Miscellaneous Publications, and is sold by the Superintendent of Documents, Government Printing Office, Washington, D. C. Price 5 cents.

The pamphlet deals specifically with some of the advantages of industrial research and the part played by this form of research in national prosperity. There is much worthwhile information within the fourteen pages of the brochure.

*Maxim Industrial Silencers* is the title of a pamphlet recently issued by the Maxim Silencer Company of Hartford, Conn. The booklet is distributed gratis, and contains much useful information about the why and the wherefore of the silencer. As the publication points out noise is offensive because it annoys one of the five senses—that of hearing, and when any one of our senses is irritated or annoyed there is an objectionable reflex action upon the other senses. Furthermore, the suppression of unnecessary or avoidable noise is of economic importance.

## ENGLISH FREIGHT CAR OWNERSHIP

MOST of the mineral traffic in England and Wales, as we learn from *The Engineer*, is carried in cars ("wagons") that are not owned by the railways or even by those who use them, but are hired from firms who make it a special business. The profits of the business are revealed in the recent prospectus of a wagon-hiring firm. It appears that the earnings of the last five years cover the preferred dividends more than five times, and after these are deducted there is left an amount equal to 10¾ per cent. on the common.

## ELECTRICITY PRODUCED MORE EFFICIENTLY

FIGURES just published by the United States Department of the Interior show that the average amount of coal used to generate a kilowatt-hour of electricity has decreased a pound since 1919. Then 3.2 pounds of coal were consumed to generate a kilowatt-hour. In 1924, but 2.2 pounds were required for the same purpose.

In 1919, a ton of coal, when utilized in a public-utility plant, produced 625 kilowatt-hours. In 1924, the same quantity of fuel produced 909 kilowatt-hours. These figures represent an increase of 45 per cent. in efficiency in the burning of coal and are based on the operation of all power houses. Some plants are producing nearly 2,000 kilowatt-hours per ton of coal.

Public-utility power plants generated 6 per cent. more electricity in 1924 than in 1923; and close on to 34 per cent. of this was produced by the use of water power. Despite the larger output, nearly 4 per cent. less coal was burned, whereas the consumption of fuel oil and natural gas increased 13 and 54 per cent., respectively. California alone used 40 per cent. of the fuel oil and 46 per cent. of the natural gas consumed by public-utility power plants in the United States.

After ranking first since 1921 in the production of electricity by the use of water power, California dropped into second place in 1924—New York taking the lead by a considerable margin. However, in the matter of generating current by fuels, California now outranks Massachusetts and Michigan, having jumped from eleventh place two years ago to fifth in line in 1924.

## COMPRESSED AIR USED TO CLEAN AUTOMOBILES

UP-TO-DATE garages now wash automobiles with the aid of compressed air. The procedure is to mix water under ordinary pressure with air at a predetermined pressure in a specially designed nozzle, thus producing a fine spray that does not impair the finish while satisfactorily cleaning the car. This is an advantage, aside from great savings in time and labor.

The object is to thoroughly soak and to wash off the dirt accumulations by the compressed-air-and-water spray so as to avoid either scratching the finish or driving the grit and dirt into the enameled surface. These things are apt to happen when a car is washed down with a sponge or with a stream of water issuing with considerable force from a hose.

But there are other uses to which air can be put in cleaning an automobile. After washing, a jet of compressed air can be turned on the ignition system and other inaccessible parts in order to quickly dry the moisture that is apt to gather there and to cause short circuiting or the rusting of metal parts. Likewise, a kerosene gun can be attached to the air line for the purpose of cleaning the engine; and, before beginning work on the outside of a car, the upholstery, cushions, etc., can be given a good dusting with compressed air.

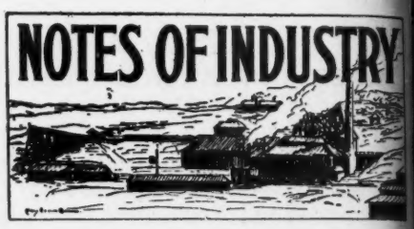
By this new method of cleaning, a much-bespattered motor car can be put in fine shape by one man in two hours. In a busy garage such a saving of effort should be worth while, and would be reflected in reduced costs for the work to the motorist.

## EXPANSION OF CANADIAN NEWSPRINT INDUSTRY

THE expansion of the International Paper Company's plant at Three Rivers, Quebec, and the building of another mill elsewhere in the province, are regarded as important steps in the newsprint industry of Canada. When completed, the Three Rivers plant will have an output of 700 tons of newsprint a day—the equivalent of a strip of paper 8 feet wide and long enough to reach across the Dominion from the Atlantic to the Pacific. As a matter of fact, it will be the largest paper mill in the world.

The same company has purchased timberland—located on the Gatineau River—which has an area equal to that of Massachusetts, Connecticut, and Rhode Island combined. The new mill is to be erected in the heart of the holdings; and, when finished in the course of a couple of years, will increase the company's output of newsprint in Canada to 300,000 tons annually or 1,000 tons a day. Just how much of an expansion this represents can best be made plain by the statement that the International Paper Company now produces 350,000 tons of newsprint in both Canada and the United States.

**Water mixed with compressed air has many advantages as a medium for washing automobiles.**




The American people spend on an average $60,000,000 a day for food, clothing, furniture, fuel and light, and for other necessities.

Substantially all the whale meat canned last year in British Columbia was exported to South Africa, where that foodstuff is considered a great delicacy.

The United States, with barely one-fifteenth of the world's population, has from three to four times as many telephones as the rest of the world combined.

We are advised by the United States consular office in Sweden that a well-known iron works in Goteborg is making experiments looking towards the production of malleable iron and steel direct from iron ore. The results so far obtained are said to be promising; but the process calls for an abundance of cheap electric power.

Much interest has been aroused by the recent discovery near Hope, British Columbia, of ore said to have a nickel content of from 1 to 2 per cent.

The mining industry of South Africa is only about 40 years old, and yet the value of the minerals produced there within that interval has reached the amazing total of 1,113,041,000 pounds sterling. Gold accounts for 71 per cent. of the amount, or £790,915,388, while diamonds come next, with £228,205,426.

Central America and the West Indies have an aggregate of 7,977 miles of railways. Of these Cuba boasts about 47 per cent., while Curacao has but one mile of line in operation. Several of the smaller islands of the Caribbean have no railroads at all.

The annual per capita consumption of lumber in the United States is about 350 feet, representing an outlay of over $15 for each person.

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